

**MULTIMODAL ANALYSIS OF MINORITIZED LEARNERS' SCIENCE
ENGAGEMENT IN AN AFTERSCHOOL SCIENCE PROGRAM**

by

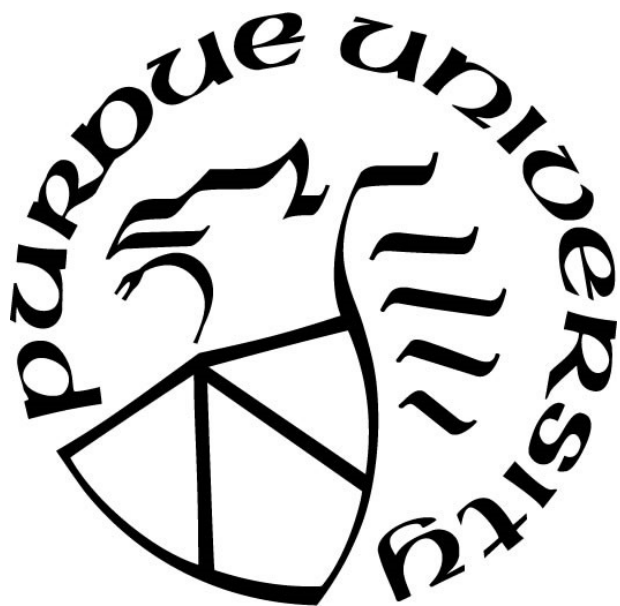
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*Dedicated to my Lola Tarhat, whose inquisitiveness inspired my love of science
and to Betty, who made me rethink what I know about science learning and engagement*

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“In the world’s broad field of battle,
In the bivouac of Life,
Be not like dumb, driven cattle!
Be a hero in the strife!

...
Let us, then, be up and doing,
With a heart for any fate;
Still achieving, still pursuing,
Learn to labor and to wait.”

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ABSTRACT

Science engagement, defined as a learners' active participation in learning, is traditionally viewed as a linguistic accomplishment. In U.S. superdiverse learning contexts, English language learners' (ELLs) science engagement is often left unrecognized because English is deemed as the sole site of scientific sensemaking, and, writing and speech as the main ways of teaching and assessment. This dissertation explores how resettled Burmese refugee youth, who are ELLs and multilinguals, engaged in science learning in RESET, an afterschool program. Combining microethnography with video analysis, I investigated how youth used multiple modes (e.g., language, gesture, posture, proxemics, etc.) in coordinating with one another to accomplish their learning task. I collected two years of data including: field notes, video- and audio-recordings of RESET sessions, digital recordings of participants' computer use, youth-generated artifacts, and semi-structured interviews. Drawing from principles of video analysis, ethnography, and multimodal analysis, I identified how learners used multimodality in their science engagement and how their strategic use of multimodality afforded productive science engagement. This work impacts education by broadening definitions of learners' science engagement; compelling educators to reassess current perspectives on engagement and restructure current ways of teaching and assessing learners; suggesting innovations on how researchers study engagement; and contributing to research on the transformation of learning spaces for more equitable instruction both in informal and formal settings. Finally, this adds to the few existing science-focused literature on refugee education and furthers our understanding of how minoritized youth agentively negotiate engagement in learning settings.

CHAPTER 1. INTRODUCTION

Changing migration movements and globalization has reshaped our social, political, economic, and educational landscapes towards superdiversity or a “diversification of diversity” (Vertovec, 2007). Across the United States, superdiversity is fast becoming the norm in K-12 classrooms (Enright, 2011). Students not only speak many different languages but also identify with many races and ethnicities, and have varied home countries, socioeconomic statuses, and migration histories (Park, Zong & Batalova, 2018). This shift towards superdiverse learning contexts has resulted in a situation where many of these students are placed in language remediation programs where “the possibility of continuing to grow intellectually [is] deferred until such time they are considered to be able to handle English” (Valdés, 2001, p.14). As a result, many of these students receive poor quality science instruction and insufficient opportunities for engaging in meaningful science learning (NSTA, 2009).

To mitigate this situation, many science educators and researchers have sought to provide students with opportunities to learn both science content and discourse along with English (Lee & Fradd, 1996, 1998; Roseberry & Warren, 2008). Yet learners’ English proficiency continue to mediate and mask their learning due to the privileging of English monolingualistic educational approaches (Enright, 2011; Luykx, Lee, & Edwards, 2008). In the science classroom, scientific acumen is often conflated with English language proficiency resulting in implicit and explicit English-only norms that hinder English Language Learners’ (ELLs) engagement in science learning (Gutierrez et al., 1995; Ryu, 2015). For minoritized¹ learners, this limits their opportunities for advancement in schooling by restricting their access to high-level science instruction (Kanno & Kangas, 2014).

My dissertation work questions the traditional view of engagement in science learning as primarily a linguistic accomplishment (Lemke, 1990) and forwards that science engagement is a multimodal accomplishment (Kress, Jewitt, Ogborn, & Tsatsarelis, 2014). This entails a departure

¹ By minoritized learners, I refer to learners who identify as being part of non-dominant communities based on language, race, class, dis/ability, etc (Chappell & Cahnmann-Taylor, 2013). I chose “minoritized” (process) over “minority” (noun) to emphasize that minoritization has been brought about by structural and institutional actions towards learners labelled as racially, linguistically, and ethnically different from the norm (Benitez, 2010).

from perceiving the English language as the sole site of scientific communication (Ammon, 2001) and writing and speech as the main ways of teaching and evaluating learners (Flewitt, 2011; Jewitt, 2003). Instead, in viewing science *engagement*, defined as an individual's active participation in science learning (Christenson, Reschly, & Wylie, 2012), I consider *all* modes (e.g., language, images, gestures, gaze, proxemics) as resources and evidence for engagement (Kress et al., 2014). Moreover, considering that languaging is inherently multimodal, the multimodal perspective I take includes *translanguaging* (Wei, 2018). Translanguaging forwards the view that multilinguals² (such as ELLs) communicate and make meaning by making full use of *all* available language repertoires (García, 2009).

My dissertation aims for the transformation of educational environments for minoritized youth and the promotion of more equitable science instruction by arguing for broadening science engagement through multimodality. In this regard, this dissertation not only seeks to explore the ways minoritized learners utilize multimodality but also how the learning setting shapes learners' science engagement, and, conversely, how minoritized learners' science engagement shapes the learning setting (McDermott, Gospodinoff, & Aron, 1978).

1.1 Project in Context

My work is situated in the changing U.S. educational landscape wherein linguistic superdiversity is becoming the norm in K-12 classrooms (Enright, 2011). My research participants are resettled Burmese refugee youth who are marginalized in U.S. schools because of their race, ethnicity, and language (Ryu & Tuvilla, 2018). These Burmese youths are some of the school-aged children who constitute the greater portion of the resettled refugees in the United States in the past decade (Capps et al., 2015).

Among the U.S. resettled refugees, there is great diversity in terms of nationalities, migration histories, education levels, linguistic backgrounds, and English proficiency (Capps et al., 2015). However, many refugee youths have experienced traumatic situations (e.g., war, violence, rape, torture), family separation, living in refugee camps where resources are limited, and interrupted schooling (Boyden, de Berry, Feeny & Hart, 2002). Hence, refugee education literature focused

² Throughout this dissertation, I refer to learners who speak multiple named languages as multilinguals to highlight the linguistic assets they bring.

mostly on addressing trauma experiences and English language acquisition, yet, fail to specify strategies to address refugee students' achievement in mainstream curriculum (McBrien, 2005). This is not in keeping with the United Nations' pledge to ensure "inclusive and equitable education" and "lifelong opportunities for all" (United Nation High Commissioner on Refugees [UNHCR], 2017).

There is limited research on the formal science schooling experiences of refugee youth, yet research suggests that informal settings such as out-of-school activities play a key role in the science engagement of minoritized youth, in general (Dierking, 2007; Lauer et al., 2006), and refugee youth, in particular (Faircloth & Tan, 2016). Minoritized youth who traditionally do not perform well in school science, perform better in informal settings, improve their science knowledge, and gain positive science identities (Leonard, Chaberlin, Johnson, & Verma, 2016; National Research Council [NRC], 2009). Informal settings make science more accessible by offering minoritized youth opportunities to engage in science comfortably (Lee, Fradd, & Sutman, 1995; Faircloth & Tan, 2016).

In my work, I leverage the affordances of the informal setting and draw data from a larger collaborative research project, *Project RESET: Refugee Youth Engaging in Critical STEM Literacy and Learning* (NSF# 1612688). RESET is an afterschool science program offered to resettled Burmese refugee youth to engage them in learning about weather, climate, and climate change.

1.2 Research Questions

My dissertation explores the ways resettled refugee youth engaged in science learning through multimodality in the afterschool setting. I seek to answer the following research questions:

- *RQ 1: How do multilingual learners use multimodality in their science engagement?*
- *RQ 2: How does the use of multimodality afford productive science engagement?*

1.3 Overview of the Chapters in this Dissertation

Chapter 1 gives an introduction to the study, provides a background to the work that was undertaken, and establishes the main research questions in this dissertation work. In Chapter 2, I describe the contexts of RESET, the design principles of its curriculum, and give background information on the setting, activities, facilitators, and participants. I also discuss the scope of the

data that was collected. In Chapter 3, I establish my positionality. This is a reflexive chapter that discusses the tensions and insights I have gained in the conduct of this work.

Chapter 4: *Analyzing Youth's Engagement Using Multimodal Interactional Analysis*, discusses the various methods used in the collection, transcription, and analysis of the data for this dissertation. Chapters 5 and 6 answers the research question on how the youths use multimodality in their science engagement. Chapter 5: *Focusing on Modes Beyond Language: Analysis of Youth Interactions in an Afterschool Science Learning Setting*, takes a close look on how youth used proxemics, gestures, postures, and images in their negotiations of participation. Chapter 6: *How Do Multilingual Learners Support One Another's Science Learning and Engagement*, focuses on how the youth used the ensemble of all the modes in their collaborative practices which contributed to their productive engagement. Finally, Chapter 7 recaps the major findings, describes the contribution of the work towards research and teaching, and recommends future studies.

CHAPTER 2. PROJECT RESET

In the United States, Midwest City³ is a popular destination for Burmese refugee resettlement due to the existence of an established Burmese community and abundance of job opportunities. It is home to about 20,000 resettled Burmese refugees who are of the Chin and Karen ethnic groups.

The Burmese Center (BC) is a non-profit community organization that renders educational, vocational, and social support to resettled Burmese refugees in Midwest City. It is located in Bluemountain Township, a predominantly Chin neighborhood. The Chins own a number of restaurants and businesses and worship in about 40 churches in Bluemountain Township.

As part of their educational initiative, BC supports Burmese high school youth by offering College Preparation Program (CPP), a year-long afterschool program that provides homework help, SAT review, and college and scholarship application preparation assistance. CPP is hosted in East Harbor High School (EHHS), one of the two high schools in Bluemountain Township.

In school year (SY) 2015-16, the Ryu Research Group partnered with BC, piloted an afterschool science program, and implemented the *Weather and Our Life* (WOL) curriculum to about 15-20 regularly attending CPP participants. The following SY 2016-17, *Project RESET: Refugee Youth Engaging in Critical STEM Literacy and Learning* (NSF# 1612688) was offered as part of CPP.

2.1 Design of the Weather and Our Life Curriculum

The *Weather and Our Life* curriculum was designed to engage Burmese youth in learning about weather, climate, and climate change. Climate change is an important socio-scientific issue and was selected not only because of its complexity and depth but also due to the urgency of the climate change crisis and the need to promote science-based climate literacy education to the youth. The sessions were designed to encourage learners to draw on their rich experiences of having lived in multiple places hence we gave prompts such as “Compare the weather of Midwest City and another area you have lived in.” These prompts brought about rich discussions on how Burmese

³ Names of townships, cities, schools, organizations, programs, and participants in this dissertation are pseudonyms.

and Americans respond to weather differently prompting teens to draw from their funds of knowledge of cultural practices of their country of origin (such as the Burmese's use of thanakha⁴) and their new home (Moll et al., 1992). We wanted to leverage Burmese youths' values and dispositions such as their desire to help others (Ryu & Tuvilla, 2018; Ryu, Tuvilla, & Wright, 2019) so we encouraged them to work with peers by having a lot of small group collaborations. In addition, we also wanted to foster their social and linguistic competencies such as the celebration of their multilingualism (Ryu & Tuvilla, 2018) so we explicitly encouraged their use of various home languages in the setting. The youth showed a lot of interest in learning about other people's cultures, languages, and experiences. In the revision of WOL⁵, I utilized my own social network and provided "real" prompts from friends who lived in other countries and climates (e.g., my former student who was at that time living in Thailand and my high school best friend who lives in Australia and was wanting to travel to Malaysia - a place where a lot of the teens had lived in). Interviews of the youth from the pilot study revealed youth's penchant for the use of social media so I created a Facebook page for RESET and provided the teens a platform where they can share video logs they have created during the course of the program. The examples I have provided is not an exhaustive list, but in designing the curriculum, we wanted to leverage youth's experiences, practices, and funds of knowledge as they engaged in the science learning of weather, climate, and climate change. I included the WOL curriculum as **Appendix A** for reference.

2.2 Organization of RESET Sessions

During the pilot year, RESET held 21 sessions in a 90-minute format. The following year, RESET met for 24 weeks although one of those sessions was a field trip to the National Weather Service, another one was a kickoff meeting designed to gather ideas for the new year, and a third one was devoted solely to working on the video project.

Sessions were organized to seamlessly transition from topics of weather to climate to climate change with a goal to create a video project at the end of the year. The first session started

⁴ Thanakha is a paste made from ground bark which the Burmese use as a cosmetic. It is said to have skin protectant properties.

⁵ My involvement in the pilot of WOL was to assist in facilitation of the afterschool program, data collection, and analysis. For SY 2016-17, I took a greater role in the curriculum design as well as the data collection, management, and analysis.

with the question “What are our weather experiences?” and succeeding sessions were planned based on learners’ inputs and ideas in keeping with a responsive teaching approach (Hammer, Goldberg, & Fargason, 2012). Table 1 shows the breakdown of the RESET lesson objectives and activities for SY 2016-17.

Table 2.1. RESET Lesson Objectives and Learning Activities.

RESET (SY 2016-2017)			
Week No.	Date	Lesson Objective	Learning Activities
1	9/1/2016	What are our weather experiences?	Learners discuss weather experiences using weather pictures.
2	9/8/2016	What are the weather variables? I	Learners manipulate a half-cut water bottle to demonstrate the principle of air pressure. They read/discuss/fill out a reading material with their small groups.
3	9/15/2016	What are the weather variables? II	Learners continue to work on reading material. Learners discuss the reading with the whole group. They manipulate a Galileo's thermometer.
4	9/22/2016	What is air pressure?	Learners do four different air pressure experiments with their small groups. They draw the mechanisms of the experiment and explain it without using the words "air pressure."
5	9/29/2016	Do we need to know about air pressure?	Learners work with their small groups and use chart paper to draw connections on what they have learned so far. They discuss what they know and what they still want to know. They make blog posts about their ideas.
6	10/6/2016	How does air pressure impact weather?	Learners construct a graphic organizer on "What makes up weather" and make as many connections as they can. They do a jigsaw reading activity. They revisit their graphic organizers to add more connections. Finally, they talk about their graphic organizers.
7	10/27/2016	What words do we have to describe the weather?	Learners play charades with weather words they have learned so far. The group takes time to define challenging/confusing words by writing down on post-its. Learners explore a weather app, Ventusky, and write insights on chart paper. They create short vlogs about their learnings.

Table 2.1 continued

8	11/3/2016	How do we compare the weather in 2 cities?	Learners watch a video wherein a friend, Ines, is asking for advice for her travel to Malaysia from Australia. Learners brainstorm how to reply to Ines and explore Ventusky.
9	11/10/2016	What is climate?	Learners create a vlog in response to Ines' question. Learners were each given pictures of plants, animals, and architecture and they try to guess the climate region.
10	11/17/2016	How do we experience climate?	Learners play jeopardy of concepts discussed so far. Learners are asked to create their own weather stories. Model products - vlog, Powerpoint presentation, and mini-book - were shown as examples. Learners paired up and worked on their Powerpoint presentations.
11	12/1/2016	How does climate impact human life? How do we impact the climate?	Learners finish their weather stories. They present it to the whole group. They reflect on the semester.
12	1/12/2017	RESET Kickoff Meeting	Facilitators and learners discuss plans for the new semester. Learners watch youth-created videos from the pilot data as an introduction to the project at the end of the semester.
13	1/23/2017	Are extreme weather events due to climate change?	Learners take a survey on what they know about climate change. Learners watch videos of extreme weather events. They break into small groups and do a jigsaw reading activity. They read about heatwaves/drought; melting ice, and warming ocean.
14	1/30/2017	What is climate change? How are extreme weather events related to climate change?	Learners review the previous week's readings by writing down on post-it notes and posting these on chart paper. They look at NASA temperature data and make causal connections with the rising temperature and extreme weather events. Learners break out into groups, do online research, and consult other resources (books, etc) to build causal maps on chart paper. Small groups present causal maps to each other and answer questions from peers. They vlog about climate change.

Table 2.1 continued

15	2/6/2017	What causes climate change? How will climate change affect us?	Learners do online research to answer: How does carbon dioxide cause the earth's temperature to rise? Does the earth's rising temperature cause more tornadoes? What areas are most affected by climate change? Learners do a gallery walk and teach each other what they learned.
16	2/13/2017	What will the earth be like 100 years from now if climate change continues? I	Learners explore the use of IR thermometers to make sense of infrared heat. They engage in a mini-lecture to clarify confusion from the previous week's discussion on carbon dioxide and the greenhouse effect. Learners create posters to answer a learner-initiated a question "What will happen in 100 years if climate change continues?" Cities that were previously discussed were given as prompts for learners to explore the question.
17	2/27/2017	What will the earth be like 100 years from now if climate change continues? II	Learners continue to work on their 100 years poster. They do a gallery walk to present their posters. The whole group discusses the predictions that worries them the most.
18	3/6/2017	Video Making: What is our message? Who is our audience?	Learners translate "global warming"/ "climate change" in various languages by writing on post-its and putting it on poster paper. Learners are assigned in groups based on their preferences. Learners are asked to make a mini-poster to recall all they know about climate change. They brainstorm and post their ideas on project folders about the purpose and audience of their video project. They vlog about the day's accomplishments.
19	3/13/2017	Video Making: What is our story?	Learners are asked about their thoughts on a post on the RESET page about whether human activity is the main cause of climate change (in reference to the EPA chief's doubts on the role of CO ₂ in climate change). They engage in mini-lecture on how to make the storyline. Learners spend develop their scripts/storylines. They vlog about the accomplishments for the day.
19.5	3/18/2017	Field Trip to the Weather Station	Learners visit the National Weather Station and interact with a meteorologist. They learn about how weather data is collected, the various instruments used for collecting data, and how bad weather alerts are sent out.

Table 2.1 continued

20	4/3/2017	Evaluating our Carbon Footprint & Video Making Work Day	Learners answer a carbon footprint survey and discuss the implications of their carbon footprints and ways to reduce it. They engage in mini-lecture on ethical video-making. They work on their video project. They vlog about the day's accomplishments.
21	4/17/2017	Deforestation & Video Making Work Day	Learners watch a clip on "Fight Climate Change, Eat Less Meat," "The Problem with Palm Oil." They note down on post-its things that surprise them and discuss the videos. They work on their video project and vlog about it.
22	4/24/2017	Climate Change and Polar Bears & Video Making Work Day	Learners watch a video on the RESET project that was submitted for the NSF STEM Video Showcase and talk about it. Learners watch two clips on how climate change impacts polar bears and they note down things that surprised them on post-its. They work on the video project and vlog about it.
23	5/1/2017	Video Making Work Day	Learners work on their video project.
24	5/9/2017	Video Showcase	Learners answer a survey on what they know about climate change. Learners show their videos to a public audience and answer questions about their video project. Learners reflect on their learnings for the entire year of RESET.

2.3 Physical Layout of the Setting

RESET sessions were held in a geography classroom in East Harbor High School. For the two years that we implemented RESET, the layout of the room remained the same. We also exerted a lot of effort to maintain how the classroom appeared for every implementation session. We took pictures of the classroom before we set up our equipment and ensured it looked about the same before we left the setting.

Upon entering the classroom, students' drawings of maps line the leftmost wall and drawings of different land formations are plastered on the back wall. Globes, textbooks, and maps are sprawled on top of the desks. A giant world map rug takes center stage in the middle of the room. Various sports magazine covers filled most of the rightmost wall that is closest to the teacher's desk. The teacher's desk is on the farthest right corner flanked by the computer. This arrangement appears to be a strategic location since the teacher can work on the computer and still see the entire class. Students' desks and chairs are arranged in an angular U around the smart board.

Another set of desks and chairs are arranged inside the larger U. **Figure 2.1** shows lay-out of the classroom.

At RESET sessions, learners freely sat according to their preference. Before the start of the 90-minute session, learners used the time to work on homework either individually or in small groups. Some used the time for socialization, watching Korean dramas in their laptops (a popular past time among the girls), or watching football on their mobile phones. Meanwhile, the research team set up data collection equipment – two video cameras, audio recorders, and laptops. We also used this time to talk to the learners to check up on them, follow up on consent forms, help them with homework, and build trust and rapport⁶.

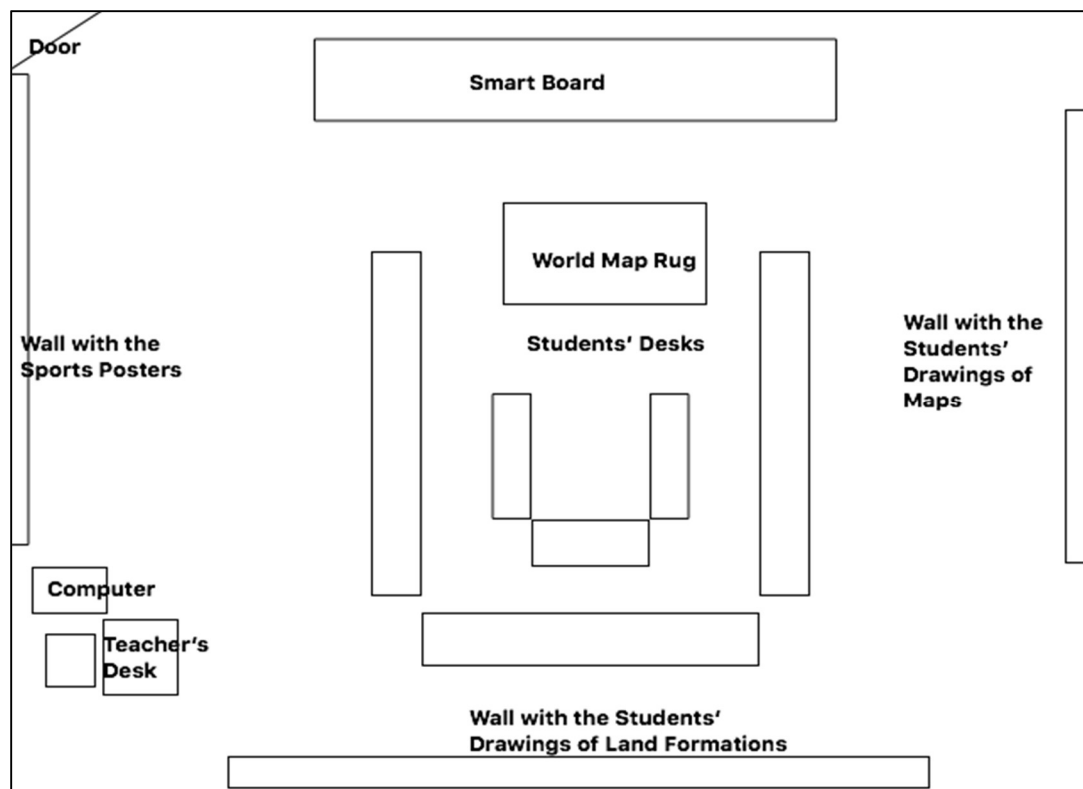


Figure 2.1. Lay-out of the classroom used for RESET sessions.

⁶ I take special note of this because although this was not captured in the video data, I would often reflect on a lot of things the learners discussed with me – from the trivial to more serious themes. Some of the things they told me I would note on my field notes. Some would be part of ethnographic information that I referred to as I analyzed my data. All in all, this was an important part of the research process.

2.4 Afterschool Implementation

RESET sessions were usually organized as follows: a warm-up, that was usually a review of what was done the previous week, 2-3 activities that involved various combinations of activities and participation structures (individual, pairs, small groups, whole class), and a wrap-up that usually involved a review of what learners accomplished and gathering learners' ideas and questions for the next week's implementation.

In keeping with the principles of responsive teaching, the sessions were designed based on what learners bring to the setting. Youth were encouraged to share ideas and were often asked: "Why?". In-the-moment changes that usually consisted of giving more time to some activities or cutting planned activities were frequent since the goal of the program was to ensure meaningful sense-making rather than finishing the prescribed curriculum.

2.5 Activities in RESET Sessions

RESET utilized various forms of participation structures (individual, pairs, small groups, whole class) in the design of its activities. Activities were designed to encourage learners' use of various modalities such as the use of images, manipulation of artifacts, drawing of images, the creation of graphic organizers, and crafting of digital stories, etc. **Table 2.2** shows a summary of common activities in RESET along with their corresponding participation structure and material resources/artifacts⁷.

⁷ There were some activities that were retained from RESET 2015-16. These activities were improved upon and new prompts were added. For the rest of the section, I only give examples from the 2016-17 implementation.

Table 2.2. RESET Activities, Participation structures, Artifacts.

Activities	Participation Structure	Material Resources/Artifacts ⁸
Warm-up/Wrap-up/Discussions	Individual/Whole class	Usually none, Post-its
Reading	Individual/Small group	Reading Materials, Post-its, Pens
Demonstrations/Experiments	Small group	Various lab equipment
Research	Individual/Small group	Laptop, Books, Pamphlets
Poster-making	Small group	Poster paper, pens
Online platforms (Blogs, Vlogs)	Individual/Small group	Laptop, Mobile phone
Gallery Walk	Small Group	Poster papers (presenter); Post-its, pens, stickers(audience)
Games	Small Group	Various artifacts (e.g., pictures, jeopardy board)
Mini-lectures	Whole Group	Powerpoint slides
Presentation	Pairs/Small group/Whole class	Powerpoint slides, Posters
Watching video clips	Whole Class	Clips from various sources (e.g., Youtube)
Worksheets	Individual	Survey, Worksheets
Video making	Small group	Camera, Videomaking portfolio

2.5.1 Whole Class Discussions

Whole class discussions frequently occurred as a warm-up or wrap-up of the sessions. Between activities, whole class discussions served as transition points and were opportunities for learners to share emerging sense-making, ask questions, and clarify confusion. At times, post-its were used to elicit ideas on the fly especially from learners who were more reticent.

2.5.2 Reading

We had a few reading activities in RESET. In one instance, I prepared a reading material for weeks (WK) 2 and 3 on weather variables⁹. In all other instances, we curated reading materials (e.g., WK 6 on various weather-related questions; WK 13 on extreme weather conditions) and/or offered books and pamphlets to learners for various purposes. Reading activities were organized as jigsaw activities where learners were assigned to various groups. Each group read different materials. Learners then re-grouped with peers from the different topics assigned and taught each

⁸ Material resources/artifacts listed are typical for the listed activities.

⁹ The reading was not utilized fully, in part to adjust to the various reading proficiencies of the learners, and more importantly due to learners' inputs. Hence, we shifted to different activities.

other their learnings from the assigned readings. Learners took turns and did read-alouds. Facilitators often checked on learners and when necessary (and possible) explain (and translate) passages.

2.5.3 Demonstration/Experiments

Learners devoted time to using simple laboratory equipment to explore scientific phenomena. For example, in WK 2 learners attempted to fill a water bottle that was cut in the middle with water all the way to the top. This was an opportunity for them to make sense of air pressure. Because air pressure garnered much interest and prompted a lot of learners' questions, in WK 4 learners did four different experiments to explore the phenomena of air pressure further. In WK 16, learners spent some time using an infrared thermometer to gain insights into how heat is transferred in preparation for a discussion on greenhouse gases.

2.5.4 Research

Research activities occurred throughout the year either via the use of laptop computers and/or books we provided. Beyond researching on prompts, learners also used laptops to explore other applications such as Google Maps to make inferences based on locations and Ventusky, a weather app that displays weather variables such as precipitation, wind direction, humidity overlaid on a global map (e.g., WKs 7 and 8).

2.5.5 Poster-making

RESET frequently utilized poster papers as a versatile material resource for sense-making where learners made connections of concepts via the creation of graphic organizers and/or causal maps. Another frequent use of posters was to display learners' conceptions and engage in dialogue with peers either through presentation to the whole class or a gallery walk.

2.5.6 Online Platforms

We had a RESET blog page that was used only once for blogging (WK 5). We shifted to Facebook which was a more popular platform since most learners already had existing accounts. I created a page exclusive for RESET participants and facilitators wherein learners can post their

questions and vlogs. Vlogs are video logs of themselves which they usually take at the end of the session to either present their work or update their progress on their video project.

2.5.7 Gallery Walk

Gallery walks were usually used in tandem with poster-making. This was an opportunity for learners to share with their peers results of their research. Peers go around the various posters and ask questions to the presenters (e.g., WK 14 on various climate-related questions; WK 17 on 100-year predictions of climate change for various cities).

2.5.8 Games

We used games to foster camaraderie among the learners. Some of the games we used in RESET were charades, word games, and jeopardy.

2.5.9 Mini-Lectures

There were a few topics that entailed mini-lectures. Of note are mini-lectures to clarify confusions from a previous session (e.g., WK 16 on greenhouse effect) and direct learners on how to proceed with the video project (e.g., WK 19 on developing storylines and WK 20 on ethical video-making).

2.5.10 Presentations

Presentations occurred frequently. Learners usually present as small groups to the class using a variety of ways such as using posters, Powerpoint slides, or storybooks.

2.5.11 Watching Video Clips

We have shown video clips to learners in preparation for the video-making project but also to introduce topics that were of interest to them.

2.5.12 Worksheets

From our experience during the pilot implementation, there was some resistance when we used worksheets possibly due to the way worksheets curtailed learners' agency. Hence, in the second iteration of RESET, we used worksheets to structure activities while allowing more flexibility. For example, worksheets were used to guide learners on their next step, but they were not constrained to put their answers permanently by writing in the worksheets (Video Making Weeks 18-23). Instead, they used post-its which they were free to place, edit, or throw as they saw fit. In a sense, worksheets became less of a tool to display final answers but for actual work.

2.5.13 Video-making Project

The video was an end-of-year output that was presented in front of a public audience (e.g., RESET and CPP participants/facilitators, guests). Learners spent a lot of time developing their storylines, researching, and producing their videos.

2.6 Facilitators

The principal investigator of RESET, Dr. Minjung Ryu (MJR), was the main facilitator. She had the decisive say on how to proceed with the activities. Learners perceived her as the main authority in the setting. She is Korean, and learners (usually the girls) expressed their fascination with this fact on multiple occasions. In many instances, learners use common Korean phrases they have learned in Korean dramas in their conversations in RESET.

There were multiple co-facilitators¹⁰ over the two-year implementation. I¹¹ was a first-year graduate student when I first joined RESET and have since been working on the project. Shen Duan was an anthropology undergraduate student when he started coming in the Spring of RESET's pilot implementation. He has always had an interest in Burma. Shen is Chinese, and learners would often ask him for Chinese language lessons. As he was the closest in age to the learners, learners often asked him to be part of their small groups. Casey E. Wright was a graduate research assistant who joined the project in November of RESET 2016-17. When she joined the

¹⁰ I only speak about the regular co-facilitators since they played a role in shaping the norms of RESET.

¹¹ I discuss my researcher positionality more in depth in Chapter 3.

project, it is with the intent of studying the science identity of those in the periphery. Casey is a White woman, born and raised in the Midwest and the only Caucasian in the setting. Though at first, she felt uncomfortable being the only non-Asian in the setting (Casey's autoethnography), she soon built a rapport with the learners. Sui and Tial are adult facilitators from the resettled refugee population referred by the Burmese Center. Sui is a math education major while Tial had just finished her bachelors in Chemistry when she joined RESET. Both speak a multitude of Chin languages, and they facilitated as well as translated for the learners in the setting.

2.7 Youth Participants

RESET participants were resettled Burmese refugee youth recruited among the CPP participants. BC did the recruitment for CPP. Those who self-selected to join RESET were either sophomores or juniors who attended either East Harbor High School or Bluemountain High School in Bluemountain Township.

All participants are of the Chin ethnic group. **Table 2.3** shows information about the regular attendees of RESET 2016-17. Most of the participants have passed through another country before resettling in the US. Most of them have experienced interrupted schooling. A lot of the youth have spent time living in Malaysia. There is a lot of variation in English language proficiencies, and the languages youth were most comfortable in speaking. In the succeeding sections, I give a brief background on the Chin refugee experience based on literature and interspersed with information the youths brought up in interviews or discussed in RESET sessions.

Table 2.3. Profiles of regular RESET 2016-17 participants.

Pseudonym Gender, Age (during RESET)	Grade Level	Age (upon leaving Chin State)	Places ¹² lived at (Place, Duration of Stay)	Duration of stay in Midwest City	Language most comfortable using	Other Languages (in order of learners’ perceived fluency)
<i>Da Hnin</i> , Female, 16	10	9	Thailand, 1.2 years; Malaysia, 2 years	6 years	Hakha, English	Burmese, Falam, Mizo, Mandarin, Bahasa Melayu
<i>Nwe</i> , Female, 16	10	5 or 6	Yangon, 7 months; Malaysia, 3 years	4 years	Hakha	English, Burmese
<i>Apple</i> , Female, 15	10	8 or 7	Yangon, 1 week; Malaysia, 3.5 years	4 years	Hakha	English, Burmese
<i>Da Zin</i> , Female, 16	10	11	Singapore, 0.5 year; Malaysia, 1 year	4 years	Hakha	English, Burmese, Zophei
<i>Thiri</i> , Female, 17	11	5	Yangon, 3 weeks; Malaysia, 2 years	9 years	Hakha, Zophei	English
<i>Rosie</i> , Female, 15	10	4	Malaysia, 6 months	9 years	Matu, English	-
<i>Nyunt</i> , Female, 16	11	8	Malaysia, 2 years	6 years	Burmese, English	Matu, Mizo
<i>Nyein</i> , Female, 16	11	?	?	4 years	Burmese	English, Lauto
<i>Mon</i> , Male, 17	11	9	Yangon, 5 months; Malaysia, 2 years	5 years	Zophei, Hakha	English
<i>Zaw</i> , Male, 18 ¹³	11	14	Yangon, 5 months; Malaysia, 1.5 years	5 years	Hakha	Zophei, Hakha, English
<i>Vincent</i> , Male, 18	11	10	Malaysia, 2 years; S. Dakota, 1 year	4 years	Mara	English, Burmese
<i>Joshua</i> , Male, 17	11	6 or 7	India, 8 years	3 years	Zophei	Hakha, Mizo, Hindi, Falam, English
<i>Lin Bo</i> , Male, 16	11	5	Malaysia, 3 years; Georgia, 8 years	3 months	English	Zophei, Hakha
<i>Kevin</i> , Male, 16	11	?	Malaysia, 6.5 years; New York, ?	2.5 years	Lauto	Hakha
<i>Jon</i> , Male, 18	10	?	(came directly from Burma)	1 year	Falam	Burmese
<i>Efraim</i> , Male, 16	10	?	(came directly from Burma)	1 year	Falam	Burmese

¹² Places listed are places lived at before resettling in Midwest City.

¹³ Zaw during my interview with him asked me whether I am asking for his real age or fake age. He told me that he uses a fake age so that he can enroll in school.

2.7.1 Chin Ethnic Group

Most Chins hail from the Chin State of Burma/Myanmar (Center for Applied Linguistics [CAL], 2007). Located in northwest Burma, Chin State is an isolated mountainous area that shares its western border with Bangladesh and India. Thus, there are also Chins in Mizoram State, Bangladesh's Chittagong Hills Tract, and India (CAL, 2007; Physicians for Human Rights [PHR], 2011). They are ethnically and linguistically diverse with at least six primary Chin tribal groups, 63 sub-tribes, and speaking at least 20 distinct languages (Human Rights Watch, 2009). The languages are not mutually intelligible although some overlap exists. The languages can be divided into four groups based on linguistic similarity and Chin geographical location. Tedim, Sizang, and Kuki are spoken in Northern Chin; Matupi, Mindat Cho, Khumi, and Asho are spoken in Southern and Plains Chin; Senthang, Zophei, and Zotung are spoken in Maraic Chin; and Hakha, Falam, and Mizo are spoken in Central Chin. Hakha (language) is spoken as a second language by other Chins because it is what is used in Hakha, the capital of the Chin State (CAL, 2007).

In various RESET sessions, learners spoke fondly of their home in the mountains and recalled various Chin attributes such as how their houses were built, how they lived in close-knit villages, having gardens in their homes, and even their manner of dress given their residence in elevated regions. They spoke multiple ethnic languages. Most participants report speaking at least two ethnic languages that they are most fluent in. The most common one spoken is Hakha while the other languages are Falam, Burmese, Zophei, Matu, and Mara.

2.7.2 Leaving Chin State

Christianity is an integral part of the Chin identity (Sakhong, 2003). Sakhong (2003) argues that Christianity “provided a means of preserving and promoting Chin self-consciousness of national identity” (p. xx). The Chins are predominantly Christian having been converted to Christianity by American missionaries since British colonization in 1896 (Sakhong, 2003). In 1961, about two decades since Burma declared its independence from British colonial rule, Buddhism was declared as a state religion (Sakhong, 2002). This led to uprisings by the majorly Christian Kachin (another ethnic group) and Chin against the central government. Soon after, a military regime emerged. The militarization of Chin State led to various human rights violation by the Burmese military (PHR, 2011). The Chins were forced to do hard labor such as transporting

military supplies, sweeping for landmines, and building roads. Abduction, torture, beating, killing, rape, and forced military recruitment were also rampant. This led to Chins fleeing to India or Thailand, with most on the way to Malaysia (PHR, 2011; Refugees International, 2005). India and Malaysia are not signatories to the 1951 Convention Relating to the Status of Refugees or the 1967 Protocol. Thus there are no mechanisms in place for provision of protection or benefits to refugees (Alexander, 2008). The Chin in Malaysia are considered illegal immigrants – “on the run, taking shelter where they can, finding employment – and often exploited – as day laborers, attempting to evade the police and immigration authorities, and often being subjected to detention and deportation” (Refugees International, 2005).

Christianity is an important identity marker to the RESET participants. Several of the youth talked about their religion as a central component in their lives influencing their dispositions towards their community and towards science (Interviews with Paige¹⁴, Lin Bo, Da Hnin, and Thiri). They joked about religious practices and talked about religious celebrations (WK 10). However, when we asked them about the reasons they left Chin State, they did not attribute it to religious persecution but mostly on attaining better educational opportunities and escaping the harsh military rule (Ryu & Tuvilla, 2018). The military took away food and resources and punished them for minor faults. Several of the participants experienced family separation when their fathers left for Malaysia or Thailand to find better circumstances for their families. They talked about staying in the jungle, getting on boats at odd hours to escape, and always being on the lookout for police and immigration authorities.

2.8 Scope of RESET Data

In RESET, we used data collection methods adapted from ethnography. Ethnography entails the acquisition of an emic perspective through participant observation or long-term engagement in the field setting wherein the researcher participates during social activities (Whitehead, 2005). Several methods of data collection were used: field notes detailing observations and informal interactions with the youth participants during the RESET sessions, video-and audio - recordings of the sessions, screencast of participants’ computer use, lesson outlines, semi-structured

¹⁴ Paige was a participant in the pilot study.

interviews with select youth, and participant-generated artifacts (e.g. digital stories, research progress blogs, posters, etc). I detail our data collection and analysis methods in **Chapter 4**.

2.8.1 Summary of Collected Data

A tremendous amount of data over the 2-year implementation was collected. A summary of all data collected for RESET is found in **Table 2.4**.

Table 2.4. Summary of RESET Data collected.

Type of Data Collected	RESET 2015-2016	RESET 2016-2017
Observation/Field Notes	Multiple counts of individual field notes by researchers	Multiple counts of individual and group field notes – both written and audio-recorded
Video-recordings (90-minute, 2-camera angles)	37 files throughout 21 weeks	44 files throughout 24 weeks
Audio-recordings	13 files (various lengths)	82 files (various lengths)
Screencast Data	17 files	36 files
Interviews	21 interviews with a total of 16 participants	36 interviews with a total of 16 participants
Lesson outlines, artifacts	Multiple counts	Multiple counts

CHAPTER 3. RESEARCHER POSITIONALITY

My training as an analytical chemist taught me that measurements are only meaningful when reported to the right number of significant figures. One can only report the numbers which your instrument can measure for certain as determined by the precision of the instrument – and that one uncertain digit. In a similar manner, education research using quantitative methodologies operates with well-established measures for objectivity, validity, reliability, and generalizability (Tracy & Hinrichs, 2017). On the other hand, assessing the meaningfulness or quality of qualitative work with its diversity of paradigms, backgrounds, and communities is a complex endeavor. Though establishing a standardized criteria is still in the works, Tracy's (2010) "Eight 'big-tent' criteria for excellent qualitative research" published in *Qualitative Inquiry* has been widely accepted as a benchmark tool. As outlined by the "Eight 'big tent' criteria" (Tracy, 2010), excellent research is marked by: 1) worthy topic; 2) rich rigor; 3) sincerity; 4) credibility; 5) resonance; 6) significant contribution; 7) ethics; and 8) meaningful coherence.

While there are multiple opportunities (and chapters) to evaluate this dissertation in terms of topic worthiness, rigor, credibility, resonance, significance of contribution, and meaningful coherence; this chapter is intended to establish the sincerity and ethics of this work. In this chapter, I attempt to lay bare my "researcher's background and biases, and the ways in which these factors might play a role in the execution of data collection and analysis" (Tracy & Hinrichs, 2017, p. 5). Moreover, good research practice compels me to establish my motivations and context while I was in the process of conducting research. Paris (2011) argues that as researchers we "can humanize through the act of research" (p.11) since it is not only "ethically necessary" but also "increases the validity" of the work (Paris, 2011, p. 1). Beyond good research practice, reflecting on how the research has changed me is also a practice of self-care (Dickson-Swift et al., 2007). The work was good and exciting but I must confess that as in any human endeavor, it was not without tensions and conflicts.

In this chapter, I attempt to establish who I was in the research and reflect on the process. Working with youth – especially resettled refugee youth – has brought me so many deep insights into the intersection of science education and social justice and along with it tensions and conflicts as I grapple with being an academic working with youth who come from communities of historical and continuing oppression. Bartolome (2010) posits that "to get on with the business of sharing

and creating knowledge” (p.177) we need to humanize work with youth. I reflect on these insights especially since I consider myself “a friend who understands fully” to the youth I worked with (Paris, 2011). It is my hope that this chapter sheds light not only regarding who I am as a researcher and the process of my work but also that it is transformative for other scholars. Milling-Kinard (1996) has issued a call for “more published accounts of investigators’ experiences in dealing with the effects on researchers of conducting studies on sensitive and emotionally laden topics” (p.69). In this chapter, I try to answer that call and share the lessons I learned working with youth, working with a vulnerable population, sustaining relationships with the youth, leaving the research site and letting go.

3.1 Researcher Positionality

I am Southeast Asian and share similar phenotypic characteristics as the learners I worked with. The first time I met the youth, I was struck with the thought that they could be my cousins as they looked familiar. I believe the youth regarded me in the same manner as I have been often mistaken for Burmese before I tell them my name or speak to them. When I tell them I am Filipino, it is often met with affinity. I believe this put me in a position where learners can project themselves in me as I look like them. Beyond physical characteristics, I related well to a lot of the experiences learners talked about in the setting. For example, in a session where we were sharing about weather experiences, I knew exactly what they were talking about on how they constructed their houses from nipa (dried coconut leaves) and how they would place buckets under a leaky roof since I have experienced the same things. For me, these were typical Southeast Asian experiences. These were the realities I lived with growing up in houses similar to what they described and understanding the nature of living in a community which values close knit family ties. In addition, I related well to the values the learners espoused and deemed as important. For example, in numerous conversations, learners talked about the high emphasis on attaining a good education for the purpose of improving socioeconomic status. They talked about wanting to do well in school. Learners also talked about the lack of financial resources that would support them in their schooling. These were the same experiences I went through in the Philippines and the very same emotions I felt when I was a teenager.

I related well to their multilingualism being multilingual myself and having grown up in a country where multiple languages are spoken in a small land area – much like the participants in

the program. For several of the youth participants who watched Philippine dramas they would ask me how to speak certain phrases (e.g., How are you?; Thank you!). I also inadvertently did the same. I learned a few words in Falam and Hakha, two of the languages that the majority of the youth spoke. Learners were always so patient and proud when they taught me to speak their language. There were numerous moments during the implementation when I would ask them about the numerous languages they speak and the nuances and relationships of the languages. It was natural for me to wonder whether there was some form of language hierarchy in Burma as it exists in Philippines. I believed this gave me insight in understanding the intricate dynamics that existed within the group of learners. I understood the excitement of learning new languages and incorporating them in everyday speech. Learners often used Korean phrases in their interactions with me and the other facilitators. I confess, I did the same as an avid Korean drama watcher. It was a point of pride and familiarity that paved the way for a feeling of closeness to the learners I worked with. I related well to the playfulness that goes with learning an unfamiliar language when one is uncertain about pronunciation and mechanics. I understood what learners meant when there are no equivalent words in English for words in their native language and vice versa and how languages sometimes have an overlap with another language. During my analysis, I reflected a lot on my own experiences as a multilingual having learned several regional languages of the Philippines out of necessity when I went to school in different parts of my country. I recalled how intricate the relationships of the different languages and how certain attributes were associated with the regional languages. The more learners and Burmese facilitators explained to me the intricacies and nuances of their many languages, the more I saw similarities in the language systems of the Philippines and Burma. I also began to understand better the sociopolitical significance of how the language we spoke can mark and identify us as certain kinds of people. Moreover, I also drew a lot on my experiences learning the English language within the Philippines along with it the implications of how I am perceived due to my grammar and accent. I contrasted my experiences in the Philippines with how I navigated speaking English in the United States. These insights were natural and instinctive for me and I felt a kinship to the learners who I deem have experienced the same things I lived through.

I have a history of having come from a country that was colonized by the Spaniards and Americans while the youth come from a country that was colonized by the British. This shared colonized past probably shaped common sensibilities as to how we position ourselves in the world.

The learners and I have a shared understanding of how it is to be marked as coming from poor third world countries. In several moments during the implementation, I have noticed the conflict of how the youth regarded their home countries with both pride and shame and the US as offering a path towards good education and better opportunities. I too shared the same sentiments of feeling indebted to the US for my education yet conflicted regarding the colonized history of my country. I carry a shared history with the youth of the marked difference of being in school in our home countries where being Asian was a norm and we spoke the mainstream language; and the discomfort of being in a new country where being Asian was a point of difference and our home languages further distanced us from the mainstream. I reflected a lot on my experiences of minoritization in school as I listened to the youths' interviews and I watched the video recordings of their interactions in the program.

I was raised in a Christian household during my formative years, have interacted with a lot of American missionaries, and spent my university years among Protestants, Baptists, and Catholics having gone to church-associated universities. This has allowed me to understand the importance of religion in the learners' lives. There were several conversations both on record and off the record where matters of faith became a theme. Yet unlike the learners, I grew up in the Philippines where Christianity was the dominant religion whereas the learners' Christianity was a reason for their persecution in Burma where the major religion was Buddhism. To a degree, I understood how it is to be of a minority religion and regarded as different as growing up a Latter Day Saint (Mormon) in Catholic-dominant Philippines, my status as a "true" Christian was often questioned.

Previously, I was a middle school and high school Chemistry teacher in Arizona. I have had experience working with learners the same age as the RESET participants. But what was more striking was the learners thought I was of a closer age to them. In a way, they thought of me as a facilitator and a friend. They would confide things in me such as their struggles in their schools and their day-to-day lives. In interviews we conducted a year after the implementation, the learners knew me by name and spoke of me as someone they trusted in the program. Beyond the implementation of the project, learners have kept in touch with me via social media platforms. I sometimes get news of their new pursuits such as universities they are attending and issues that are of salience to them.

In terms of immigration status, an important aspect of learners' daily lives, I related to a degree especially in the context of anti-immigrant US politics. I recall how documentation was so important in the learners' lives as they spoke of the stigma of illegality they experienced in their third countries prior to their resettlement and the time it took for them to be vetted prior to their migration to the US. As an international student in the US, I have been subjected to numerous interrogations and perusal of my documents as I crossed the border. Because I am a Chemistry major, the processing of my visa took longer than others because my major was considered dangerous. There have been at least two occasions when I was jokingly asked by TSA officers whether I am in the US to make bombs. I have had multiple experiences where I was asked to step out for additional questioning and presentation of proof that my presence in the United States is legal. Though my migration to the US was voluntary in pursuit of my education, there is a heavy sense of feeling unwelcomed and proving that my US presence is legal. I believe this has given me an insight in understanding, at least to a degree, how the learners were regarded in the US in terms of their immigration status. Yet I acknowledge, that I have the ability and the privilege to come home to my country whereas the youth I have worked with have to go through a lot to escape their home country. While several of them profess to wanting to come home, they acknowledge the difficulty of doing so.

Despite the many experiences I draw on to relate to the learners, I have to acknowledge the privileges that I come with. I have not experienced what it is like to be a refugee – to leave my country due to persecution, war, or violence. I have not had to hide from the police and to live in fear of being discovered as “illegal”. I have not been subjected to child labor nor had my schooling interrupted. In fact, in terms of my education, despite the financial struggles I had scholarships that supported me. I look back and conclude that my education had been a privilege. It is this recognition of my privilege that gives me this sense of responsibility in doing this work of improving the educational circumstances of minoritized learners. This is my positionality and the identity I come with in this work.

3.2 Working with Resettled Refugee Youth

Doing work with resettled refugee youth is tantamount to going into the youths' lives and asking them to recollect experiences (Cannon, 1992; Ribbens & Edwards, 1998). There were numerous moments when I felt vulnerable, guilty, exhausted, and hopeless. There were moments

when I felt the youths' pain, anger, and feelings of injustice as they shared with me painful pieces of their lives. There were also moments of great joy and hope as they shared their victories and accomplishments. In this section, I share a few key moments that had impacted me in the research. Each one shaped my awareness and sensibility during the research process. In addition, I summarize key insights that hopefully will help future researchers engaging in sensitive work.

3.2.1 Feeling Vulnerable: Youths' Stories of Escaping Burma

I was a newbie researcher when MJR asked me to listen to Daisy's¹⁵ interview in the process of initiating me to learners' migration histories. By then, I had met the youth for a few weeks. I have started to reshape my previous views on who refugees were. Prior to meeting the youth, I had no idea who the Burmese were and why they were refugees. I was just excited to be invited to do "research". At that time, research meant very differently for me. I was coming from a Chemistry background and had no previous experience with doing research on human subjects. The literature I read in preparation to meeting the participants though helpful were abstract to me. Looking back, I did not have the ability to grasp the possible impacts of the work both to the participants and to myself as a researcher.

Prior to meeting the learners, my understanding of refugees was borne out of popular media narratives that characterized refugees as people in a perpetual state of misery from war-torn countries. Most of the media's visual framing of refugees emphasizes their helplessness and passiveness as victims of violence (Guererro & Tinkle, 2010). My first impression of the youth was "They could be my cousins". It was this sense of familiarity that propelled me to rethink my initial views of refugees. The youth were vibrant, eager to learn, humorous, and active. They laughed constantly and bantered with me. However, this was just one dimension to the complexity of the youth participants.

I listened to Daisy's interview wherein she recounted how they escaped to Thailand and hid in the jungle for fear of the police. One of the most haunting things as I listened to her recollection was how her mother hid family photos in her mother's very long hair. Daisy talked about how her mother was forced to cut her beautiful hair. She also spoke of how her mother had

¹⁵ Daisy was a participant in the pilot program and was one of the interviewees in the Urban Review article (Ryu & Tuvilla, 2018).

to hide in the trunk of a car and how she got hit. As this was the first interview I listened to, the impact on me was visceral. She laughed in certain moments as if to distance herself from the event. Yet I felt her pain and her fear. I had to pause several times as it was devastating to me to imagine her, a very young girl escaping in the jungles of Thailand.

I have to admit that listening to Daisy's and other youths' interview and also conducting numerous interviews where youth talked of the violence they had experienced were trigger moments for me. Transcription was particularly hard as I had time to reflect and "[absorb] the voices and stories of research" (Warr, 2004, p. 586). I have become vulnerable in numerous moments and it had allowed me to examine other aspects of my life (Behar, 1996).

In listening to stories of escaping, I was brought to recall my own story of escape and the guilt that comes with escaping. There was a time in my life when my father was addicted to *shabu* (methamphetamine) and there were many violent episodes which I distinctly recall. I detailed in numerous journals I have kept over the years of how at one point, my father threatened my mother with a Kris sword (a wavy sword commonly found in Mindanao, Southern Philippines). My mother locked herself in my youngest sisters' room and pleaded for my father to leave us alone. My father continued to threaten us that he will burn down our house. I had to remove the glass windows in the dead of the night, climb out the window, and walk barefoot. The rest of my family were able to escape save for my brother who is deaf and sleeping in the next room. I called the cops to pick up my father. The cops did not come as my father's family was infamous in its influence in the city. There were many more incidents but because I went to school away from home, I was spared. I carried this guilt with me when I think back on how my siblings and mother took the brunt of the abuse.

I share this snapshot of my past to drive home the point that there was no way I could have anticipated how the youths' stories would affect me in such a personal way. While I was new in the research process, I often felt conflicted regarding my vulnerability and my struggle to remain objective. But perhaps because I was a novice, I came into those interviews less inclined to possess hardened assumptions and less likely to take knowledge I was gaining for granted.

I look back on my field notes and found that what had helped me over time was continuously journaling how I felt in those moments of vulnerability. The research process forced me to face painful memories that I have struggled to compartmentalize and distance myself from. Though I did not share in-depth with any one person what I was going through at that time, I was

able to debrief small portions of it with various people in my support system focusing more on *my experiences* while omitting the events that participants mentioned in the interview that triggered it. However, while debriefing was a matter of self-care, I constantly felt conflicted recalling painful stories participants told me.

3.2.2 Working with Trust: The Dilemma of Being a Researcher and Being a Friend

In the course of my interactions with the youth, the line between researcher and friend became murkier. Each week before the camera rolled, I talked to the youth about their lives. We shared jokes and recommendations for Korean dramas to watch. They asked for help and I offered help with their homework. One had reached out to me asking me to review a class paper outside of RESET hours. Eventually and naturally, the youth found me on social media. Being new to the work, I was in a dilemma of how to respond to the Facebook friend requests. I discussed the issue with MJR and we agreed that there was no harm in accepting friend requests. In the second year of the implementation, Facebook became a platform to share posts and video products within the RESET participants. Yet when implementation ended, learners remained as part of my friend network.

The youth would like my posts and comment on them. I would at times get updates regarding their activities. There were also a few conversations when the youth turned to me for advice on things beyond RESET and school. Other times they would update me about news regarding their friends in RESET.

While implementation ended, I was still in the middle of analysis and writing about the learners. Despite anonymizing the data and referring to them with their pseudonyms, I felt like I got to know the learners more as I broke down their interactions into smaller and smaller fragments of time in my analysis. I scrutinized every word, gesture, every nod, every lift of an eyebrow, every smile, and every joke. At times, I found myself listening to private conversations. These were conversations that happened when they forgot the camera was rolling and their audio was being recorded.

While it was easy to decide excluding video-recorded and audio-recorded conversations I deemed we were not supposed to be privy to, it was harder to delineate what was data and what was information that the learners were offhandedly giving me by virtue of our friendship. Ellis

(2007) commented: “We became friends with those we studied because we couldn’t help ourselves, and because it made our work easier while we were there. However, friendship was secondary to our research purposes, and when we left, our relational loyalties shifted to readers and professional associations” (p. 10).

In working with these young people, I constantly felt guilty and conflicted. On one hand, I was being thorough as an ethnographer, but on the other hand, where did my loyalties actually lie? I was mortified when on the second year of the implementation, I found there were so many research studies being conducted with these youth ranging from medical and dental health studies to language and education research. I was wracked with researcher guilt.

My emotions will always remain in conflict but I now reflect on it as a good thing. Ellis (2007) advises to “think it through, improvise, write and rewrite, anticipate and feel its consequences” and more importantly “to seek the good” (p.23). As a qualitative researcher, wrestling with guilt appears to be a small price to pay to ensure that I am always reminded “to seek the good” and remind myself where my loyalties should lie.

3.2.3 “When are you coming back?”: Leaving the Research Site

At the conclusion of the implementation of RESET, I struggled a lot with leaving the research site. Conventional notions presuppose that the research site is a school, a classroom or a bounded space where the researcher can and must exit at the end of the study (Figueroa, 2007). However, working with minors from refugee backgrounds, it was a struggle to remain the detached ethnographer according to conventional expectations. I had to distance myself from the conventional standards driven by positivistic notions (Eisenhart & Towne, 2003). I reasoned that it was for the greater good to maintain my ties with the research participants even after the research was done.

Figueroa (2007) urges researchers to ask: “Have we acknowledged and fulfilled our responsibility to the communities who have welcomed us? Have we -in both our own opinion and the opinion of the participants – fulfilled the commitments we made at the beginning of the study? “(p. 170). When our research team ventured on this study, we often reminded participants the purpose of our work. We discussed the objectives of our work in the afterschool program during interviews when youth participants themselves asked us why we were there. However, naturally

over the course of time, our relationships with the participants evolved, and along with it the expectations our participants had of us.

Since I had some of the youth participants in my social media, several of them would ask me “When are you coming back?” Though we had an end of the year party to conclude our program and we announced that we will not be holding an afterschool program the following year, the youth expected us to come back. This was something I did not anticipate and I realized that in the opinion of our participants we were supposed to come back.

Two years after the last afterschool session, I went to a Burmese restaurant and met two of the youth participants. They called me by name and were excited to talk to me. They hugged me and told me they missed me. They updated me of what has been going on with their lives. We took a picture together. Before we parted, they invited me to visit them at the non-profit center. I share this anecdote to drive home the point that though we – the researchers and the participants – may have left the research site, we cannot sever the relationships we have established. Thus, the idea of a detached ethnographer is a myth when one works so closely with the community.

I end this subsection with a quote from Figueroa (2007): “Our failure to account for how researchers leave the field – how they can responsibly extricate themselves from an ethnographic situation that binds the researcher and researched....is a troubling area of silence” (p. 170). For researchers working with human subjects, we need to pay more attention to the manner which we depart from our research sites.

3.3 Conclusions and Recommendations

I write this out of concern for researchers who are starting out with researching sensitive topics and vulnerable populations. While “do no harm” is a standard rule, this not only applies to participants but to researchers as well. Even the most veteran of researchers cannot fully anticipate how the research process may impact personal lives. I therefore recommend that support systems be in place for the psychological safety of researchers. This means that in teaching research classes, there should be added emphasis on how researchers must do self-care. Methods of self-care may include journaling and having a support group where one can freely talk about tensions and conflicts regarding the research process. In research groups that do human subject research, conversations regarding vulnerability and humanizing research must be normalized. These discussions are necessary and crucial to ensure the physical and mental health of researchers.

While informal support groups of friends and family are important, the university can provide group sessions wherein a formal group of researchers who do similar work can counsel and debrief one another. Of course, with confidentiality issues at stake, the focus of the formal group would be on researcher experiences rather than on participant information. Since the formal group would consist of researchers, utmost care will be given towards ensuring that participant information is not shared. Finally, we ought to evaluate the conditions of the Institutional Review Board to also implement channels ensuring researcher welfare.

With regards to issues on departure from the research site, it is our responsibility as researchers to ensure that our exit strategies are sound and feasible. Paris (2011) admonishes us that as researchers we need to “push against inequities not only through the findings of the research but through the research act itself” (p. 140). Perhaps, we can ask our participants to tell us what the end of participating in the research would mean. We can then engage in discussions where we account for the terms of the relationship we have established and emphasize both the possibilities and the limitations of our research. On the university side, perhaps, committee members can urge emerging scholars to bring the notion of departure in methodological conversations and advice scholars to consider the complexities involved in maintaining and breaking relations with participants. In addition, perhaps our IRBs also ought to ask for more detailed plans on how we depart from research sites. By doing so, we can foster care and understanding, and humanize our research.

CHAPTER 4. ANALYZING YOUTHS' ENGAGEMENT USING MULTIMODAL INTERACTIONAL ANALYSIS

A version of this analytical chapter will be submitted for publication. Authors: *Mavreen Rose S. Tuvilla, Casey E. Wright, Purdue University; Minjung Ryu, University of Illinois- Chicago; and Shannon M. Daniel, Vanderbilt University*

Abstract: This paper presents an account of our data collection, processing, and analysis of video data from an afterschool science program engaging Burmese refugee youth in learning about weather, climate, and climate change. In our interactions with the youth, we found that talk-based approaches were limited in understanding the rich network of multimodal resources from which youth drew on in their sense-making. In this paper we take an interactional approach to multimodality – looking at how language, gesture, proxemics, posture, gaze, and layout were used agentively by learners as part of their science engagement. Our methods entailed video analysis of multi-layer videos, multimodal transcriptions, and collaborative workflows for microanalysis. We share three events that demonstrate our analysis and the insights our approach offered us. Through this analysis we see that learners coordinated *space* with one another, used *gestures* to show embodied knowledge, and used *images* in navigating science topics as part of science engagement.

4.1 Introduction

A goal of this paper is to provide a detailed account of how we collected, processed, and analyzed data that captured Burmese youths' interactions as they engaged in science learning in Project RESET, an afterschool program. More importantly, beyond sharing the mechanics of the data collection, processing, and analysis, this paper provides a demonstration of the additional insights we can glean from doing multimodal interactional analysis. We argue that multimodal interactional analysis can provide us insights regarding youths' engagement that are not captured by talk-based approaches alone.

The youth participants we worked with are multilinguals who spoke multiple Burmese ethnic languages in varying proficiencies (Hakha, Falam, Zophei, Mara, etc.) and English in varying proficiencies. We found early in the implementation of the afterschool program that the flexible use of multiple languages as well as the use of modalities other than spoken language were important aspects of how the learners communicated in the setting. Thus, we became interested in investigating how learners used multimodality in their interactions and in their science engagement.

Oral participation has been emphasized in American classrooms because it is assumed that verbal students are more engaged compared to quiet students (Schultz, 2009). However, existing research indicates that oral participation is not the most important indicator of students' engagement in learning (Bainbridge-Frymier & Houser, 2016). Moreover, English-monolingual approaches are forced upon racially- and linguistically-minoritized learners to encourage verbal participation (Creese & Blackledge, 2015; Valdés, 2001). Math and science classes are usually English-only (Boals, 2001) and sheltered approaches for English Language Learners (ELLs) offer highly simplified content (National Academies of Sciences, Engineering, and Medicine [NASEM], 2018). These structural barriers lead to the limited access of minoritized learners to meaningful STEM learning (NSTA, 2009). In contrast, minoritized youth who traditionally do not perform well in school science, perform better in informal settings, improve their science knowledge, and gain positive science identities (Leonard, Chabern, Johnson, & Verma, 2016; National Research Council [NRC], 2009). We are of the stance that informal settings make science more accessible to minoritized youth by offering opportunities to engage in science comfortably (Lee, Fradd, & Sutman, 1995; Faircloth & Tan, 2016). Thus, we designed and implemented an afterschool STEM program, Project RESET, to provide meaningful opportunities for resettled Burmese refugee youth to learn about weather, climate, and climate change.

While implementing the program, we collected ethnographic data (e.g., videorecordings, interviews, artifacts) to answer research questions regarding multilingual learners' engagement and learning. In collecting and analyzing our data from multiple sources, we drew guidance from numerous published books and articles that describe techniques of video analysis and multimodal analysis (Derry et al., 2010; Jordan & Henderson, 1995; Norris, 2004) but found ourselves adapting and "inventing" new ways of processing our video data. It is our hope that by sharing our approaches this would be helpful to researchers who do video research and/or study classroom interactions with minoritized learners.

4.2 Motivation for Research

Science education reform efforts have called for students to *engage* in scientific and engineering practices (NRC, 2012). However, engagement in practice is viewed as a language intensive activity (NGSS, 2013). There appears to be a tacit expectation that learners' engagement is a linguistic accomplishment. In our work, we question this language-centric view of engagement

in science learning because although we acknowledge that oral participation is *one* indicator of learners' engagement, engagement is a multidimensional metaconstruct comprised of cognitive, emotional, and behavioral components (Fredricks, Blumenfeld, & Paris, 2004).

In this work, we forward the view that engagement in science learning is a multimodal accomplishment (Kress, Jewitt, Ogborn, & Tsatsarelis, 2014). We veer away from perceiving language as the sole site of scientific communication (Ammon, 2001) and writing and speech as the primary ways of teaching and evaluating learners (Flewitt, 2011; Jewitt, 2003). Instead, we consider all modes (e.g., language, proxemics, gestures, gaze, images, etc) as resources and evidence for engagement (Kress et al., 2014).

In presenting this study, we sought for insights we can draw using multimodal interactional analysis about the ways in which multilingual learners engage in science learning. We ask: 1) what can this analysis show that talk-based approaches do not capture? and 2) how can these insights bring us to re-evaluate multilingual learners' science engagement?

4.3 Review of Literature and Guiding Frameworks of the Study

4.3.1 What are Modes?

Since this work bridges EL education and science education, in this section we clarify our stance regarding modes. In majority of EL education work, modes are taken as the channels by which language is communicated (Grapin, 2019). In this context, modes traditionally refer to speaking, listening, writing, and reading. From this perspective, language is the standard way by which meaning is communicated and all other (non-linguistic) modes are imprecise representations (Lemke, 2002). Thus, in EL education the prevailing view promotes language acquisition as the main goal while all other modes are only reinforcements or scaffolds for the learner -and as such are not legitimate forms of meaning-making and expression. In contrast, the prevailing view in science education is that modes include both linguistic and non-linguistic meaning-making resources (Grapin, 2019). For example, in the science classroom, graphs, tables, and equations are necessary disciplinary tools. They are not merely supports to language but are legitimate-meaning making resources (Kress, Jewitt, Ogborn, & Tsatsarelis, 2014). We align with this more inclusive definition of modes that affords learners opportunities to communicate ideas more effectively using multiple ways of representing their learning beyond language.

Modes are systems of representation that are shaped by social and cultural influences (Norris, 2004; Kress 2014). Modes include language, gesture, proxemics, posture, gaze, layout, print, music, etc. *Language* has a sequential structure wherein the small components (words, clauses) build up to larger components (sentences) organized in grammar and syntax (Norris, 2004; Kress, 2014). In our work, we expand our views on language beyond the English language since our participants are multilingual learners. In our analysis we consider the learners' entire linguistic repertoire and posit that learners draw from an integrated system comprised of the diverse languages learners know. This languaging practice is termed as translanguaging (García & Wei, 2014). *Gestures* describe the movement of hand/arm, head, and other parts of the body to communicate (Goodwin, 2003). The meaning of a gesture can be interpreted by looking at the gesture holistically and in parts in such that gesture can combine many meanings (McNeill, 1992). Unlike language wherein parts of a language (e.g., morphemes, words, etc.) can be meaningful, the parts of a gesture do not have an independent meaning (Norris, 2004). Some gestures co-occur with language, others do not coincide with language, while other gestures can co-occur but depict a different message from the occurring language (Norris, 2004). *Proxemics* account for the distance one takes up in relation to others (Norris, 2004). Proxemics can give us insights towards the kind of social interaction that is going on because a person's spatial perception is related to action (Hall, 1966). *Posture* are ways by which one positions their bodies in an interaction (Norris, 2004). *Gaze* refers to the way people organize and direct the positioning of the head, particularly the eyes, in reference to their environment (Goodwin, 1981). *Layout* refers to the environment (setting, objects, etc.) that structures the interaction between participants (Norris, 2004). Layout plays an important role in an interaction by providing topics for discussion and shaping the course of the interaction (e.g., natural boundaries of the objects/space determine who may speak to whom and at what point; de Saint-Georges, 2004). Modes such as *music and print* (e.g., written text and images) can be disembodied or embodied (Norris, 2004). The mode becomes an embodied mode when an actor uses mode or print to express perceptions, thoughts and feelings (e.g., a musician playing the ukulele, a person writing a list of grocery items). On the other hand, the mode is disembodied when an actor reacts to the music or print created by others (e.g., a person reading a list of grocery items).

4.3.2 Our approach to Multimodality and Science Engagement

We take a multimodal approach in our work due to two main observations regarding the U.S. educational landscape. First, educational settings remain rooted in traditional notions of monolingual norms of teaching and are unprepared for the multilingual shift (Creese & Blackledge, 2015). Second, there is a high emphasis on “talk” as a demonstration of engagement (Bainbridge-Frymier & Houser, 2016).

In the United States, the English language assumes the status of a specialized register in subjects such as mathematics and science since these subjects are mostly taught in the English language (e.g., for ELLs, English immersion science classes) (Lee, 2005). Thus, in this sense, science acumen becomes conflated with English proficiency since acquisition of oral and written English and exit from ESOL or ESL programs are fundamental in determining science outcomes as they are commonly assessed (Lee, 2005). This is also reflected in policy documents that impact ELs wherein there is an assumption that English proficiency equates to academic language proficiency (WIDA, 2007). On a larger scale, policies that govern science teaching and learning also set a high expectation for learners to demonstrate English language proficiency to demonstrate their science learning (NGSS, 2013).

Language plays an important role in describing learning processes and assessing science and math outcomes as reflected by the many studies on teacher talk, student response, and analysis of written texts (For example: Carr et al., 2006; Moshkovich, 2002; Schleppegrell, 2007). This imposition of language-centric approaches has resulted into a reductive conceptualization of both learners and language itself (Kibler & Valdés, 2016). Language practices are complex and cultural contexts play a role in how learners enact languaging practices (Kim, 2002). Kim (2002) reminds educators that “students’ silence can be the engagement in thoughts, not the absence of ideas” (p. 840). Studies of Rogoff and colleagues (2003; 2007) also support the notion that culture plays a role in how learners interpret talk as indicator of learning and engagement. For example, in Roberts and Rogoff’s (2012) study, US Mexican-heritage learners had a more inclusive definition of talk that included “talk[ing] with their hands and eyes” (p. 93). These cross-cultural studies of how cultural backgrounds play a role into learners’ conceptions of what constitutes interaction and engagement suggest that engagement should be analyzed more closely using modes that go beyond spoken language - modes that include the hands and eyes.

To this end, we take a multimodal approach where we attend to the multiple modes used

in a learning setting. Thus, language is not the central focus of our analysis but one of the modes that informs our understanding of how the process of teaching and learning science is accomplished. We acknowledge that in interactions, multiple modes are inherently used simultaneously. We take the stance that meaning is embedded in *all* of the modes and each of the mode contributes to the overall meaning of the multimodal ensemble in specific ways (Kress et al., 2014). By using a multimodal approach, our attention is drawn on learning aspects beyond language and we uncover insights on how learners agentively use multiple meaning-making modes in their science engagement.

We conceptualize learners' engagement by attending to how learners contribute to learning tasks (Engle & Conant, 2002). Engle and Conant (2002) propose that there is *greater engagement* when: a) more learners make more substantive contributions towards accomplishment of the task, and in doing so, b) learners coordinate with one another rather than work by themselves, c) are mostly on-task to achieve their objective, and d) sustain their involvement on the learning task over an extended period of time. Engagement is indicated by how e) learners attend to one another through coordination of gaze, posture, and gesture and f) learners' animated display of emotions. Thus, in this sense, multimodality affords us the ability to interrogate learners' engagement.

In viewing learners' engagement, we are of the view that engagement is manifested via multimodal ways (Kress et al., 2014). Shifts in the modes can reveal patterns of attention and patterns of navigation. For example, a change of posture can signify a change in interest as evidenced by the change in alignment of the learners' body positioning to the teacher. A change in a learner's proxemics through closing the distance and entering the navigation space of the peer or shifts in the visual display through moving the cursor of the mouse can signify different kinds of engagement (Bezemer & Kress, 2015).

To investigate learners' engagement, we attended to each mode per Norris' (2004) suggestion. Our data necessitated richness and depth to observe multimodal shifts. We carried out our data collection and analysis with an ethnographic view in mind. We "consider[ed] whole events...analytically decomposing them into smaller fragments, and then...recomposing them into wholes" (Erickson, 1992, p. 217). We considered the entirety of the implementation, viewed entire sessions, fragmented sessions into segments and events, and put together our analysis informed by our understanding of individual events, participants, and activities and the entirety of our interactions in the research setting. We used video analysis techniques employed by Derry and

colleagues (2010) to select events such as: individually watched unedited video recordings and chose potential events for close analysis; collaboratively viewed selected events, and generated video logs and analytic memos. We drew on multimodal interactional analysis and converted video data to multimodal transcripts and evaluated the complex interactions of modes (Norris, 2004). We viewed the data iteratively with and without sounds; focused on the various modes separately and combined; synchronized multiple camera angles as well as computer screencasts; and generated transcripts to capture multiplicity and coordination of communicative modes. We studied how learners used language (English and non-English languages), images, gesture, action, proxemics etc. Attention to the different modes allowed us to draw deeper insights to the meanings learners constructed in the moment (O' Halloran, 2011).

4.4 Carrying out the Work

We now devote this section of the paper to explain the data collection, processing, and analytical approaches we employed to enable us to do multimodal transcription and analysis of youth's science engagement that were captured in their interactions in Project RESET

4.4.1 Data Collection

We used several methods of data collection. In this section, we detail our data collection approaches.

Field notes. Since the first three authors facilitated the implementation and our work spanned multiple years, we had a variety of interactions with the youth participants. The first three authors conducted participant observations and documented these through field note taking (Bernard, 2006). The field notes were especially crucial in capturing interactions with the youth that were not audio-/video-recorded. For example, we had conversations with the youth that occurred before and after the session and/or interviews. We also had exchanges with the youth beyond the afterschool setting (e.g., the nonprofit organization, cultural events that we attended). There were also things that the youth told us in confidence. As part of good research practice and researcher self-care, we wrote individual field notes.

Our individual field notes varied in format but in general we wrote about the various interactions we had with the youth that were interesting. Mostly we talked about our impressions regarding the particular day's implementation – what worked and did not work, the youths' reactions and reception towards the activities we had that particular session, and our observations on how the youth interacted with one another. Sometimes we also wrote about information youth told us regarding their migration and school experiences. At times, they would also tell us about their families and what troubles them.

We did collaborative reflection on the approximately 80-minute drive from the research setting to the university. We audio-recorded these conversations. We usually discussed what went well or did not go well in the session, reiterated ideas the youth shared in anticipation of planning for the next session, and shared information about our individual interactions.

We kept a shared group field notes where the authors had the freedom to share what was pertinent to the research and withhold what may be deemed too sensitive for sharing¹⁶. We exercised our own discretion in determining what we felt we can and cannot share in pursuit of the good (Ellis, 2007). Our field notes kept us accountable towards our observations since we drew a lot of the ethnographic information from the field notes and our analysis were inevitably influenced by our understanding of our youth participants.

Video-recordings. All afterschool sessions were videorecorded following recommendations by Derry and colleagues (2010). High definition cameras were used, propped on tripods and equipped with receivers for microphones. The cameras were strategically placed to capture the best angles of the classroom where the research was conducted (See **Figure 4.1**). Two cameras – one, for the “wide” perspective with a fisheye lens attachment and the other for focal perspective were used. The wide perspective camera was placed facing the learners. Since this camera had the fisheye attachment, this could capture the entirety of the setting save for some blind spots. There are two microphones connected to the wide perspective camera. One was a shotgun microphone that captured the surrounding audio and was used during whole class discussions. The other microphone was a lapel microphone (not included in the illustration) that MJR wore and was used

¹⁶ I had an interview with a participant which continued after the audio-recording was stopped. These were things that I felt were better kept between the two of us – especially since the participant made sure that it was off the record.

to capture her interactions with the learners. The focal perspective camera was placed at the back of the room, angled towards the smart board capturing a different angle than the wide perspective camera and/or angled towards focal learners. A Bluetooth receiver was connected to it, with the Bluetooth microphone capturing focal learners' interactions. **Figure 4.1** shows the typical placement of the cameras and their respective microphones in the Project RESET setting.

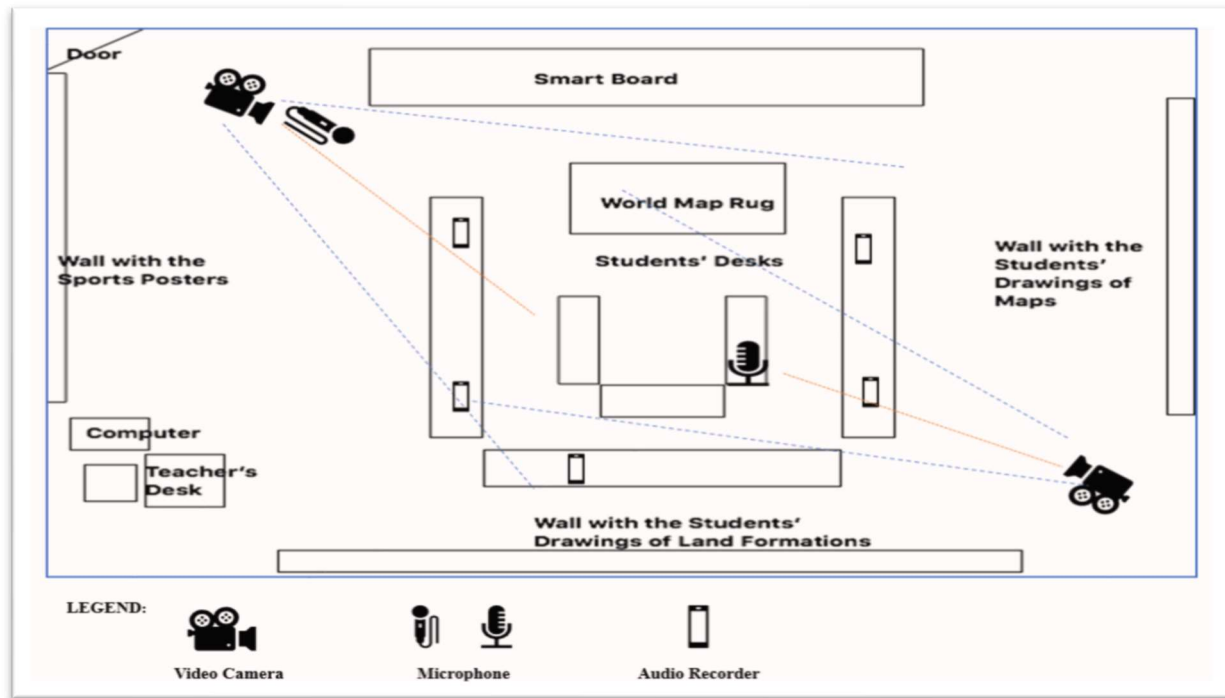


Figure 4.1 Placement of Data Collection Equipment

Audio-recordings. Audio-recorders were used to capture conversations among participants (Derry et al., 2010). During the first half of the implementation, the voice recorders were worn by the facilitators throughout the session. Eventually, when learners worked with the same groups during the video making project, the audio recorders were placed in learners' tables (See **Figure 4.1**).

Screencasts and Artifacts. When learning activities required online research, screencasts of participants' computer use were captured. We used Camtasia software to capture learners' computer activities. Participant-generated artifacts (e.g., posters, Post-it notes, Powerpoint slides, video logs, blogs, etc.) were photographed or recorded depending on their medium. This approach

allows for the understanding of the participants' sense-making by studying not only their utterances but also semiotic artifacts such as print materials, videos, etc (O' Halloran, 2011).

Interviews. Semi-structured interviews were conducted with 16 youths in 2015 and 16 youths in 2016. Each semi-structured interview lasted for about an hour to 1.5 hours and was video-and/or audio-recorded. We treated interviews not as a report of content but a co-construction by the participants of the interview (both interviewer and interviewee) (Baker, 2002). In several of the interviews, selected photographs and video clips that showcased youth as they were engaged in the moment were used as prompts (Clark-Ibáñez, 2004). The photos and videos helped the participants of the interview recreate moments from the session, relive their experiences, and articulate their perspectives (Clark-Ibáñez, 2004).

4.4.2 Data Management

With our large scope of data collection, we needed to ensure that our data collection ran smoothly. MRST created a list to check equipment, data collection, and processing before, during, and after each session as well as a task list for members of the research team and other facilitators (See **Appendix B** for an example of the checklist and task lists).

4.4.3 Video Data Analysis

Our video data consisted of 90-minute recordings of two different camera angles. We now outline the steps in our treatment of video data. We want to emphasize that though we outline the process in a linear fashion, the process was not always straightforward. (See **Figure 4.2** for a diagram on the workflow process).

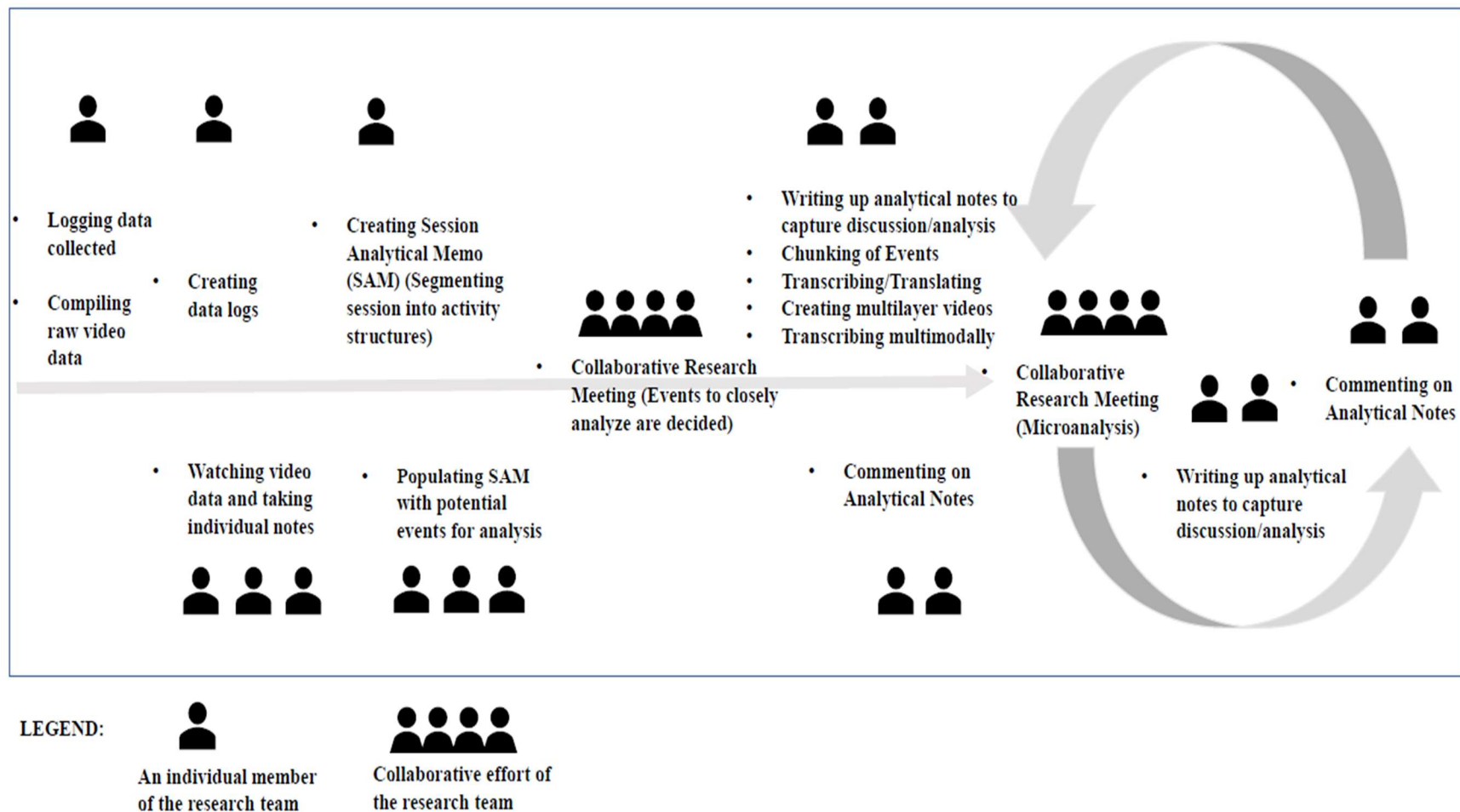


Figure 4.2 Workflow process for video data analysis

Logging data collected. We collected a large scope of data and we needed a way to manage our data corpus. MRST created an Excel File that detailed all the data we collected for a particular week. This allowed our research team to account for all the data available and access other data sources when analyzing a particular week's video. (See **Appendix B** for example of the Excel file log.)

Compiling raw video data. Raw data files were transferred from the video cameras to a secure hard drive and a password-protected computer as prescribed by the Institutional Review Board. MRST compressed the raw data files which are usually 1GB to 2GB in size into smaller file sizes (usually around 200MB) using Handbrake (<https://handbrake.fr/>). Handbrake is an open source video transcoder that can process most multimedia file format and convert them into web shareable files. The compressed data files were uploaded to the secure data server (Purdue University Research Repository, PURR) for individual research team members to access and download.

Watching video data and taking individual notes. Research team members downloaded the video files to watch individually. Individual viewings entailed watching a session in its entirety, multiple viewings of potential events for close analysis, and writing down notes to be brought into the research team discussion. Individual members' notes varied in format. For example, SMD (fourth author) made a Word document that had her transcription of moments she found interesting and her interpretations and initial analysis while MRST created data logs.

Creation of data logs. Norris (2004) suggests that data logs of each video recording should be created. Data logs are short summaries of what transpired in the video. MRST created detailed data logs for all the sessions using Inqscribe (<https://www.inqscribe.com/>), a transcription software that allows earmarking moments for further analysis. These data logs described what happens in the video in enough detail to be able to recreate a minute by minute description of Project RESET activities (See **Figure 4.3** for example). Usually, MRST used the wide camera perspective for this initial viewing of the video data to create data logs for the overall session. A separate data log was created for the focal camera perspective that focused on a different angle or interactions of specific learners.

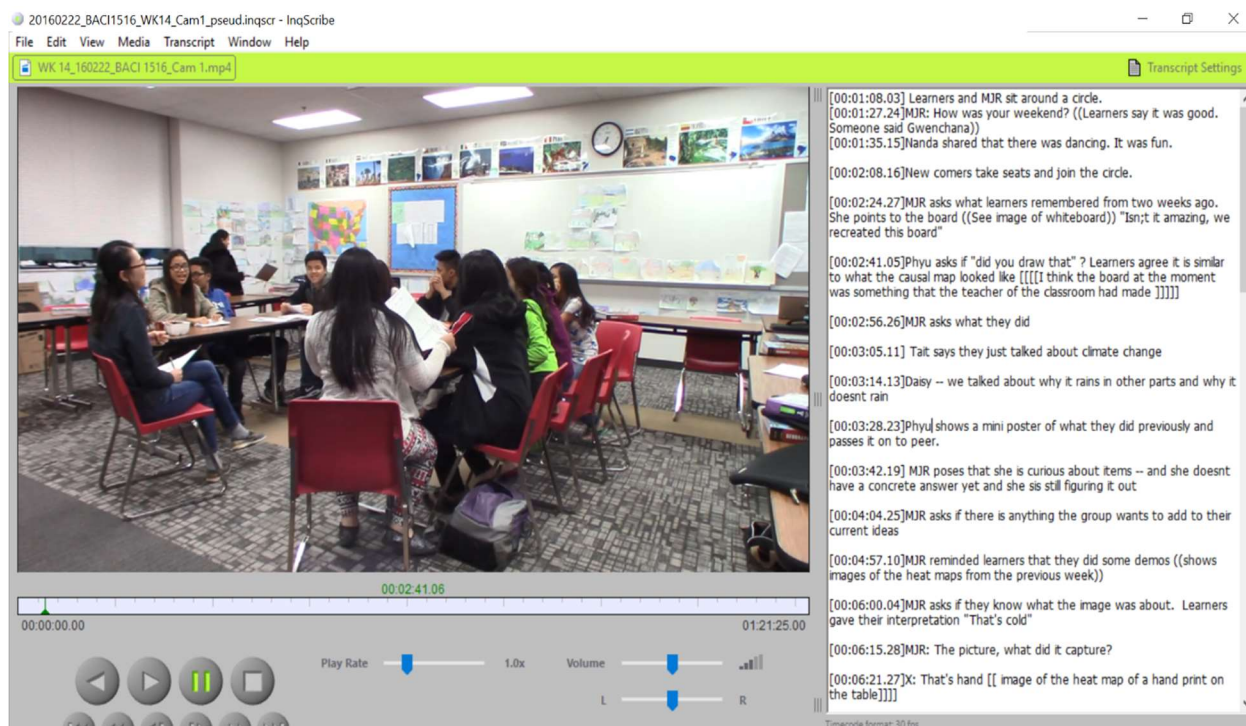


Figure 4.3 Screen capture of Inqscribe showing an example of a content log

Creating of the Session Analytical Memo (SAM) and Populating the SAM with potential events for analysis. MRST created a session analytical memo (SAM) in Word based on the data logs. The SAM was uploaded to Google Doc for sharing with the research team members. Research team members would put forward potential events for close analysis. When we first began our video data analysis, we left selection of events open-ended. Each individual member came up with 2-3 events that caught their interest in their initial viewing.

The SAM was created by segmenting a 90-minute session into phases of learning activities (e.g., opening exercises, poster making, gallery walk, etc.) (See **Table 4. 2**, for example).

Table 4.1 Example of segmentation of a RESET session into phases of learning activity

PROJECT RESET 2016-17 Week 17					
Segment #: Name	1: Opening exercises	2: Research/ Poster making	3: Gallery Walk	4: Discussion	5: Wrap Up
[Start Time – End Time]	[START – 00:06:42.22]	[00:06:42.22 – 01:01:56.21]	[01:01:56.21 – 01:23:20.25]	[01:23:20.25 – 01:32:54.19]	[01:32:54.1 9 – END]

Project RESET sessions were usually organized as follows: a warm-up, that was usually a review of what was done the previous week, 2-3 learning activities that involved various combinations of activities (e.g., research, poster-making, discussion, etc.) and participation structures (individual, pairs, small groups, whole class), and a wrap-up that usually involved a review of what learners accomplished and gathering learners' ideas and questions for the next session. (See **Figure 4.4** for example).

Week number : Title – indicates the session number and learning objective	Week 10: How do we experience climate?
Lead author of the memo	Lead Author: Mavreen
Session Overview – a summary of what transpired in a session	<p>Session Overview: Only a few participants attended this session. Participants played Jeopardy on weather/climate related topics. In preparation for their own weather stories, three different models for presentations were shown (Liam's vlog, Shen's powerpoint presentation, MT's story book). Participants formed pairs. All dyads chose to make a powerpoint presentation and spend the rest of the session creating their own weather stories.</p>
Segment number and Activity Phase	<p>Segment 1: Opening exercises Cam 2 [START – 00:05:45.19] Participation Structure: Whole group</p>
Camera Number and Time Stamp – indicates the video source of the segment	Participants move to the inner circle. MJR asks where everyone went since only a few participants are there. Sol makes an announcement. Kevin jokes if they can pray first. MJR says that there will be a game and the winner gets cookies. Ronan (a new boy) walks in and asks if he can join. Participants decide to group themselves 3 on 3 - Ronan, Joshua, Kevin vs Mon, Nyunt, Bella. They do rock-paper-scissors and Mon's group goes first. MJR encourages the group to "make a loud noise so the people outside can hear."
Segment Overview – a descriptive note of what transpired in the segment	
Event number and Title (Initials of the author of the transcription)	WK10_1.1 "Let's pray first" (CW)
Camera Number and Time Stamp – indicates the video source of the event	Cam2 [00:02:02.00]- [00:02:55.15]
Keywords – shorthand for possible themes	Keywords: negotiation of practices, joke making
Transcript	<p>Transcript:</p> <p>1 [00:02:02.00] MJR: Umm</p> <p>2 [00:02:03.26] Joshua: Let's pray first ((hand in front of face, said in a mumble))</p> <p>3 Nyunt and Bella: ((giggle))</p> <p>4 [00:02:05.07] MJR: What? (looks at Khen)</p> <p>5 [00:02:06.06] Kevin: Lets pray</p> <p>6 [00:02:07.02] MJR: Let's what?</p> <p>7 [00:02:08.23] Joshua: (sits up, smiles) pray</p>

Figure 4.4 Anatomy of a session analytical memo. Participant names were changed.

The process of segmentation was a way to organize data into manageable chunks and keep track of the various activity structures used in the entirety of the implementation. We used the segmentation not only in the creation of SAM but also in building year-long event maps that highlight the lesson objectives and learning activities (Kelly & Chen, 1999; See **Appendix C** for example).

The writing of the SAM was not always straightforward. In most of the cases, MRST and/or CEW wrote *descriptive notes* that summarized what transpired in a segment along with the highlighted time codes of the various events. These events that have been earmarked are then discussed in the collaborative research meeting. A typical example of a list of events in a RESET session is shown in **Table 4.3**.

Table 4.2 Example of the events list in a RESET session.

Event#	Time	Event Name
1.1	00:02:01.24- 00:05:38.19	"We'll do Sydney"
1.2	00:05:44.27 - 00:08:32.00	"Are you Da?"
2.1	00:07:30.05 - 00:12:21.08	Thiri and Da Zin share resources
2.2	00:14:04.02 - 00:19:31.02	"And after we read about climate is we can figure out what might happen"
2.3	00:14:04.02 - 00:19:31.02	"..wait, is Sydney like farming, is it popular in Sydney or something?"
2.4	00:19:35.08 - 00:23:03.12	"Which one do you wanna do?"
2.5	00:23:06.24 - 00:28:43.12	"How long have you been here?"
2.6	00:34:57.04 - 00:50:19.19	"This is not for school so it feels better"
2.7	00:50:27.26 - 00:54:53.13	"We're being artists now"
2.8	00:56:38.17 - 01:00:44.05	"And like she said, ..."
3.1	01:09:39.24 - 01:10:42.03	Da Zin explains to Da Hnin
3.2	01:16:08.24 - 01:18:00.05	Thiri explains to Vincent

Collaborative Research Meeting (Selection of Events for Close Analysis). Deciding which events to look at closely entailed a lot of deliberation among research team members. In these discussions, other sources of data were discussed to ground what is happening in the video such as group field notes, material artifacts, interviews, etc. Our main consideration was whether selected events had the potential to answer our research questions. Discussion continued until consensus as to which events to analyze was reached.

Over time, patterns emerged in what individual research team members found worthy to earmark. Selected events usually involved rich interactions among participants (learners and facilitators) and forwarded learners towards achieving an objective.

Write up of Analytical Notes. After each meeting, MRST and CEW would write additional details on the descriptive notes and write analytical notes of the events to capture the discussions from the meeting. *Analytical notes* included arguments pieced together from the ethnographic information and the video-recording as well as other artifacts on hand. In more elaborate analytical notes, turn-by-turn interpretations of transcripts were also written. Events that did not make the cut were earmarked with a keyword.

Chunking of Events. MRST or CEW chunked selected larger events into smaller, analyzable events. Events are “smaller units of coherent interaction” or “ethnographic chunks” (p. 57, Jordan & Henderson, 1995). Each event starts with the context of what triggered the action (e.g. instructions, a new micro-goal, a new stressor); which mostly induced a change in the participation structure, and ends with another trigger. This chunking strategy ensured capturing the contexts that led to the interesting interaction and the outcome of those interactions within an event. The events in our study usually ranged from one to five minutes long on average, the longest being 10 minutes.

Transcription/Translation of the Language Mode of Selected Episodes. After chunking the events, MRST and CEW transcribed the utterances per Norris’ (2004) suggestion to transcribe the language mode first. We used Inqscribe for transcription. Since none of us spoke any of the Burmese ethnic languages our participants spoke, we transcribed the English utterances and noted the utterances spoken in Burmese ethnic languages.

To translate the non-English utterances, we worked with translators who identify with the same resettled Burmese refugee population. We worked with three different translators- Emily Tluangneh spoke Hakha; Cherry Ania Kap spoke Falam; and Tial spoke Hakha, Falam, and Burmese. Emily and Ania were undergraduates at Purdue University and CEW and MRST would sit with them as they translated the non-English utterances. This allowed the researchers the opportunity to ask the translators for their interpretation of the interactions. For example, there have been moments when Emily would laugh at particular interactions, so we noted down possible interpretations of the interaction. Tial was a RESET facilitator and MRST would send transcripts and video files via secure server for translation. Tial would return transcripts indicating what particular Burmese ethnic language was spoken as well as explanations for certain occurrences we inquired about. We note that because we had three different translators there were differences in the words/phrases they used to translate non-English utterances to English. For example, in reference to an utterance by a participant directed to a group, one translator might translate it as “Guys...” while another may say “Hey, everyone...” We note this as a limitation to our work. The translations usually gave us deeper understandings of learners’ sensemaking. However, we note that there were events that we selected initially but decided not to analyze after the translation. Some were side conversations and at times personal conversations that as researchers we felt we should not be privy to.

Creation of Multilayer Videos. The raw video data files (RVD) were good to use in our first run through of analysis. The RVDs allowed us to focus on one video angle at a time. However, we needed a way to view the interactions we were interested in holistically. Thus, our analysis necessitated the creation of multilayer videos (MV). We created MVs of sessions that were of particular interest to us as syncing entire sessions was easier than syncing smaller data chunks.

The multi-layer video was comprised of: the salient camera angles (whole group and/or focused on focal participants), audio recordings (if the video sound quality is poor), and screencast (if available). The multi-layer video allows the approximation of a holistic view of the interaction since it contained all the salient data sources that may be important in further analysis. MRST and CEW created multi-layer videos using Camtasia software (<https://www.techsmith.com/video-editor.html>). Camtasia software allows addition of multiple layers of video, audio, and subtitles.

Creating MV in Camtasia required syncing of video and audio especially since the RVDs come from different sources. Camtasia allows the zooming in and zooming out of the audio layer so that the audio waves can be inspected. We used the markers to aid in the syncing (See Camtasia tutorial videos for more details; <https://www.techsmith.com/blog/category/tips-how-tos/>). We aligned the *audio waves* of the two camera angles (and screencast if available) to sync the *video*. When we collected data, we used a clapper at the start of video-recording. The clapper caused a spike in the audio waves and served as a marker in syncing audio waves. We synced the camera angles first, since there are visual and audio cues that can be used for syncing. When videos were synced, screencast video was added by once again aligning the audio waves.

When the video sound quality was poor and there are better sound sources (e.g., audio-recorders or the recording from the screencast data), we added additional audio layers. We did this by: 1) separating the audio and the video layers of the original video; 2) syncing the audio waves of the original audio and the new audio (this may require tweaking the properties of the audio which is a capability in Camtasia); and 3) substituting the new audio for the original audio. (See **Figure 4.5** for example)

We added the subtitles that consisted mostly of the utterances by exporting the Inqscribe file of the transcription and importing it to Camtasia. When important to the interaction being analyzed, we also added of other modes (e.g., gestures, images, etc). For example, learners are discussing what they are viewing on the laptop computer. The multilayer video has the screencast of learner's computer use and we indicated that in the subtitle We made adjustments to ensure proper timing with all the synced video and audio files. Once all the relevant layers were completed, we rendered the video to create a local file of the final multilayer video



Figure 4.5 Camtasia screen capture showing layering and syncing of videos and subtitle track.

Multimodal Transcription. The transformation of video data into multimodal transcripts is not merely a descriptive or translation process but also an analytical process (Bezemer & Mavers, 2011). The process entails iteratively paying attention to the modes individually and as an ensemble, what the function of the modes are in the moment-to-moment interaction (Norris, 2004). Our multimodal transcripts varied in form depending on our research aims and the quality and context of the video data that is the subject of our analysis. In transcribing multimodally, our intent was to capture utterances, gesture, body posture, gaze, computer use (e.g., typing a search term), organization of artifacts and use of space and attend to each of them by their salience in the interaction (Norris, 2004). We believe that through nuancing the various modes we would be able to uncover insights we would miss out on if we only paid attention to the modes as an ensemble. Hence, our approach was to look at modes individually and as an ensemble.

In the examples we show later, we tried to capture a variety of multimodal transcripts. In general, we assembled the multimodal transcripts as follows: 1) We differentiated moments or actors using turn numbers. In some cases, we gave descriptions of participants' higher-level actions. Higher-level actions are actions that consist of an assembly of multiple modes (Norris, 2004). For example, an experiment performed by a small group (higher level action) consists of shifts in

gestures, posture, proxemics, gaze, and utterances.; 2) When there are utterances, they follow the names of speakers; 3) When lay-out is salient, a still image of the lay-out is included. Images may be magnified depending on analytical focus; 4) Movement is captured by taking stills of a series of images. This is done by taking still images of the video clip. We used Inqscribe since it allows zooming on a particular time stamp as well as modifying the rate of play. We used Inqscribe's toggle feature to forward images one frame at a time. Gesture images were then cut from surrounding lay-out using a touch pen and an interactive screen using the Snipping Tool app on a Windows computer. Some movement may be indicated via descriptions (e.g., laughter, movement of the mouse, etc); 5) Annotations such as circle to indicate the material artifact, double-headed arrows to indicate proxemics, and single-headed dotted arrows to indicate gaze and/or body position were included depending on analytical focus; 6) When there are screencasts, material artifacts, and other disembodied modes that are important in the analysis, we included screen captures and/or images.

Commenting on Analytical Notes. When multimodal transcripts were finally assembled, MRST and CEW wrote descriptive and analytic notes to capture additional findings gleaned from the multimodal transcription. The Session Analytic Memo would then be revised accordingly and sent out to all research team members. MJR and SMD (fourth author) then wrote out comments, counterarguments, and other possible interpretations.

Collaborative Research Meeting (Microanalysis of Selected Events). The research team then met and collaboratively micro-analyzed the events selected for close analysis, combining multiple insights from research team members, and constantly revisiting earlier analysis when new insights were made available (Derry, et al., 2010). We would play the video-recordings of the selected event iteratively and grounding our assertions about what is happening on the video in the materials at hand (Jordan & Henderson, 1995). From these discussions, we generated themes by grouping common keywords of events.

After each meeting, MRST and CEW added on the SAM to capture the discussion and analysis. MJR and SMD then wrote out comments, counterarguments, and other possible interpretations. We did as many iterations of this step until we reached saturation in our analysis and no new insights come up.

4.5 Examples

We now present examples that demonstrate the application of our analytical approaches. We showcase different participation structures and activities as well as various combinations of modes in the examples we present here. Example 1 captures a group activity wherein learners are manipulating materials to explore air pressure. Although we have access to some of the learners' use of language, the transcript focuses mostly only on proxemics, posture, and gaze. Each transcript box captures a change in arrangement of bodies over a time span of four minutes and creates a narrative using mostly the mode of proxemics. Analytically, this allows us to gain insights when focus is on proxemics, gesture, posture, and gaze. Example 2 captures a whole class discussion wherein learners are attempting to define an unfamiliar word. The transcript combines language as well as images to capture the layout and focus on the gestures. Analytically, this captures how gestures add a layer of meaning that language alone is unable to bring about in this learning moment. Example 3 focuses on a focal learner's engagement and the power behind the use of screencast data in tracking learner's engagement. The transcript combines the modes of language and images focused on learner's use of the laptop and gestures. Analytically, this allows us to make learner's sensemaking visible.

4.5.1 Example 1: Focus on proxemics, gesture, posture, and gaze

The following event transpires in Week 2 of RESET 2016-17 at the Burmese Center rather than the classroom at East Harbor High School where majority of the sessions were implemented. There was an event at the high school and thus we had to adjust for the contingency. Thus, in this particular data collection, we had to modify where we placed our data collection equipment. The room we utilized was irregularly shaped as this was shared with Burmese Center employees. There were also no desks and so we had to rely solely on the shotgun microphones to capture the audio. Moreover, the lack of desks meant that movement among groups was not constrained.

Learners were given a bucket of water and a half-cut bottle. They were challenged to fill the bottle with water up to the top. The intent was for learners to explore how air pressure works. Learners broke out in small groups. Several participants fluidly went around groups to observe and come up with ideas. We turn our focus on Thiri, Ei, and Nyein as they engaged in trying out possible solutions to the challenge in their small group.

Transcript 4.1 Exploring Air Pressure



1 At the center of the action, Thiri is crouched down to the bucket. Her hands are on the bottle inside the bucket as she tries out a possible solution to the challenge along with other group members.

Thiri: So, put it in like this, stand, and then

SD: Here is, uh, the cover

Thiri: You wanna cover it?

.....

Thiri: Does anyone want to help?

Meanwhile, Nyein is in the periphery. While her gaze is focused on the bucket, she remains at a distance from the bucket.



2 Ten seconds later, Nyein crouches down and approaches the bucket. Nyein's gaze remains on the bottle. Meanwhile, Thiri is gesturing a possible solution to other members who have access to the bottle.

Thiri: So, like push it in. And then I'm just gonna cover that. Do you wanna cover that?

SD: Ah yeah. Top, ***

Thiri: And then do you want me to cover this after that?

SD: Yeah. You cover the cap

Thiri: So, while it's in the water, you cover it.

SD: No, this one would break so, I don't know

Thiri: I don't know what I'm doing. It's 'cause the bucket is too small. Okay and then did you cover that?

SD: Yeah




Thiri: Oh, that's pretty cool. Maybe after putting that in, maybe we should squeeze it so that this part like closes in

SD: Yeah, we can try


Thiri: Yeah, we can try that. Let's try that guys. I'll put the cap in. And then do you want to put the cap in?

SD: Yeah

Transcript 4.1 continued

	<p>3 Another learner, Ei arrives and joins the group. Her gaze is towards the bottle. Nyein's gaze continues to focus on the bottle while Thiri remains in the center of the action.</p>
	<p>4 SD and Thiri continue to try possible solutions.</p> <p>SD: You wanna squeeze? Like this Thiri: Like that? Do you want me to put the cap in? SD: Yeah, cap is here</p> <p>In the periphery, Ei and Nyein gesture towards one another as they explore possible ways to manipulate the bottle and try out possible solutions.</p> <p>Ei: It's not that way. You have to ((Gestures with a twisting motion)) Nyein: No, ***. Oh, so like ((Nyein repeats the twisting motion)) *** Yeah, I don't know. Let's see</p>
	<p>5 Thiri gets excited when water starts to rise up the bottle.</p> <p>Thiri: IF this works ****. I got it, I got it.</p> <p>The water falls back down and the group erupts in laughter.</p> <p>Thiri steps back as Ei and Nyein approach the bucket.</p>

Transcript 4.1 continued

	<p>6 While Thiri fully steps back, her gaze remains focused on the bottle.</p> <p>Ei and Nyein manipulate the bottle and are now at the center of the action.</p>
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Throughout this event, the entire group coordinate proxemics, posture and gaze thereby showing high engagement in finding possible solutions to the challenge. At the beginning of the episode (**Turn 1**), Nyein is constrained by space and thus is unable to reach the bucket. Yet Nyein's gaze is fixed towards the bucket indicating her attention and interest in the task at hand. When she saw space open up where she may insert herself (**Turn 2**), Nyein crouches down to get closer to the center of the action. After Ei joins the circle (**Turn 3**), Nyein turns to Ei and strategize ways they may manipulate the bottle as shown through their gestures (**Turn 4**). Having been at the center of the action and having had the opportunity to try multiple possible solutions, Thiri now steps back (**Turn 5**) and gives way to Ei and Nyein. Yet even with stepping back, Thiri's gaze remains fixed towards the bottle and the bucket indicating her continued engagement to the task (**Turn 6**). Thiri's giving way removes the constraint of space from Ei and Nyein as both finally approach the bucket and the bottle (**Turn 6**). Ei and Nyein move towards higher engagement in the task at hand as they finally are able to manipulate the bottle.

Although we focused on the actions of Thiri, Ei, and Nyein, we also acknowledge the contributions of the two silent group members. Throughout the entire interaction, the two group members on the left side have not spoken once. However, we see their continued engagement throughout the entire activity indicated by their manipulation of the bottle and sustained gaze towards the center of the bucket.

The coordination of space allows for collaborative work whereas the coordination of posture, gestures, and gaze facilitate continued engagement. When learners are able to coordinate

space appropriately, this fosters equity in opportunities to engage in the learning task. As how one may dominate another through language via talking over and not allowing for interruptions, allowing for silence gives others a chance to share their ideas; In the same manner, giving way through the modes of proxemics and posture fosters equity in enacting ideas.

4.5.2 Example 2: Focus on language (word play and phonetic resources) and gestures

In this episode from Week 3 of 2016-17, learners are engaged in a whole class discussion to unpack an activity that required them to read short passages and answer a few questions. We include an excerpt of the prompt discussed in the following figure (**Figure 4.6**).

What is weather? What do we mean when we say “weather”? In this reading, we will learn about different aspects of weather.

What was the weather today like? How would you describe it? Was it sunny, rainy, or cloudy? Think of 5 more adjectives to describe weather and draw a symbol/picture that you associate with the words you came up with.

--	--	--	--	--

In the box below, sketch what a typical weather is like in Chin State (or anywhere you used to live) and

Figure 4.6 Excerpt of RESET 2017 Week 3 Worksheet

We created the following transcription key based on the Jeffersonian (1984) Transcription Notation:

Table 4.3 Transcription Key

Symbol	Name	Use
1	Bolded numbers	Turn number
[Text]	Brackets	Start and end points of co-occurring speech
((<i>Italic Text</i>))	Double parentheses	Annotation of action or description
Text ^A	Bolded letter (superscript)	Indicates that the turn has a still image associated with it
Text ^(A-C)	Bolded letters in parentheses (superscript)	Denotes still images of gestures in a sequence, taken in 1s increments to capture movement
A	Bolded letters	Denotes the still image associated with a turn
<u>Text</u>	Underlined text	Denotes text read from a source (e.g., computer, book, etc.)
(.)		Denotes a pause
(hhh)		Audible inhalation/exhalation
***	Asterisk (s)	Unclear speech
:::	Colon (s)	Indicates prolongation of an utterance
ALL CAPS	Capitalized Text	Indicates shouted or increased volume speech

Everyone is seated on the floor and form a circle. Snacks are being passed around. MJR asks the group about ways they have described weather. Learners offer the words they had put in as weather examples. Many of them talk all at once indicating great engagement in the discussion. They offer words like “thunder”, “moist”, and “rainy”. MJR asks them to elaborate and explain their contributions. In this snippet, MJR asks the learners to define an unfamiliar word “muggy”.

Transcript 4.2 Muggy

- 1 MJR: Does anyone have something like muggy?
- 2 Sandi: Oh, uh what's that one word that everyone^A



- 3.5 Sandi: [Humid?]
- 3.5 Cho: [Moist]
- 4 MJR: Muggy
- 5 MJR: Do you know what muggy means?
- 6 Sandi: No
- 7 MJR: Does anyone know?
- 8 MJR: Muggy. Muggy.
- 9 ((Learners giggle))^B



Transcript 4.2 continued

- 10 Zaw: I thought you said ((Laughs)) I thought you said monkey
11 ((Learners laugh))^C



- 12 MJR: No, no, not monkey
13 Thiri: Is it a mix of foggy and mud? ^{D, (E)}



- 14 MJR: Ohh, that's a good guess, yeah

Transcript 4.2 continued

15 Mya: Is muggy like gooey? F, (G-I)



16 MJR: ((Laughs)) Yeah, yeah kind of, it's really hot and humid^J



Transcript 4.2 continued

17 Mya: It's like stickier^{K, (L-O)}



18 MJR: Yeah, yeah, yeah, yeah, yeah

19 Sandi: That's my bus P. (Q-S)



In this episode, learners make use of various modal resources available to them to define the word muggy. The snippet begins with MJR asking learners if they know the word muggy (Turn 1) and learners Sandi and Cho offer “humid” and “moist” to start the discussion going (Turn 3.5). Co-occurring speech is typical in whole class discussions when learners are motivated to generate ideas. In our work in the afterschool, we found this as an indication of engagement where learners felt comfortable to explore ideas (though they may be uncertain). We have found that the casual atmosphere in the setting encourages youth to take more risks in their participation.

The comfortable atmosphere of this setting is evident in the way facilitators and learners alike are sitting on the floor, sharing cookies as they unpack the activity. This sets the tone for joking and laughter as shown in (Turn 9). Zaw’s word play of likening muggy to monkey (Turn

10) elicits laughter from the group (**Turn 11**) encouraging more learners to offer ideas though they may be uncertain.

Thiri offers a definition of muggy as a combination of foggy and mud (**Turn 13**) as she holds up her middle and index finger, indicating two (**E**). Her gesture conveys her mixing of two separate ideas of foggy and mud which at first glance appear to be incompatible. Her creative answer points to the use of phonetic similarities and tracing back to **mud** and **foggy** as the possible root words for **muggy**.

Mya continues on this idea of phonetic similarity when she offers the word “goosey” (**Turn 15**). As she utters the word, her body wiggles and her hand moves (**G-I**) to indicate her embodied knowledge of how goosey feels like. For her peers who may have not encountered the word goosey, her gestures and body movement add a layer of modality to convey the meaning of sticky.

MJR’s laughter and affirmation of Mya’s answer (**Turn 16**) yet also indication of uncertainty through her use of “kind of” motivates Mya to expand on her earlier answer. Mya attempts for a second time and she uses the word “stickier” (**Turn 17**), as well as a series of hand gestures (**L-O**) to appear as if there is something sticky on her skin. Once again, beyond her talk, her gesture conveys the meaning of stickiness.

MJR agrees with Mya (**Turn 18**). Upon hearing this, Sandi relates the experience of being hot and humid as mentioned by MJR in an earlier utterance (**Turn 16**) to how it feels like in her bus (**Turn 19**). Sandi’s example is particularly relatable to this group who arguably have had experience being in a hot and humid bus. On the side, Mya gestures how sweat streams down from her face to her body in a rhythmic fashion (**Q-S**). This gesture is most likely directed to Sandi to relate to her example as seen in the direction of Mya’s gaze. However, to several of the learners whose gazes are directed towards Mya, Mya’s gesture is possibly another opportunity (along with the various attempts in the entire episode) of learners learning the meaning of “muggy”.

4.5.3 Example 3: Focus on use of images and gestures

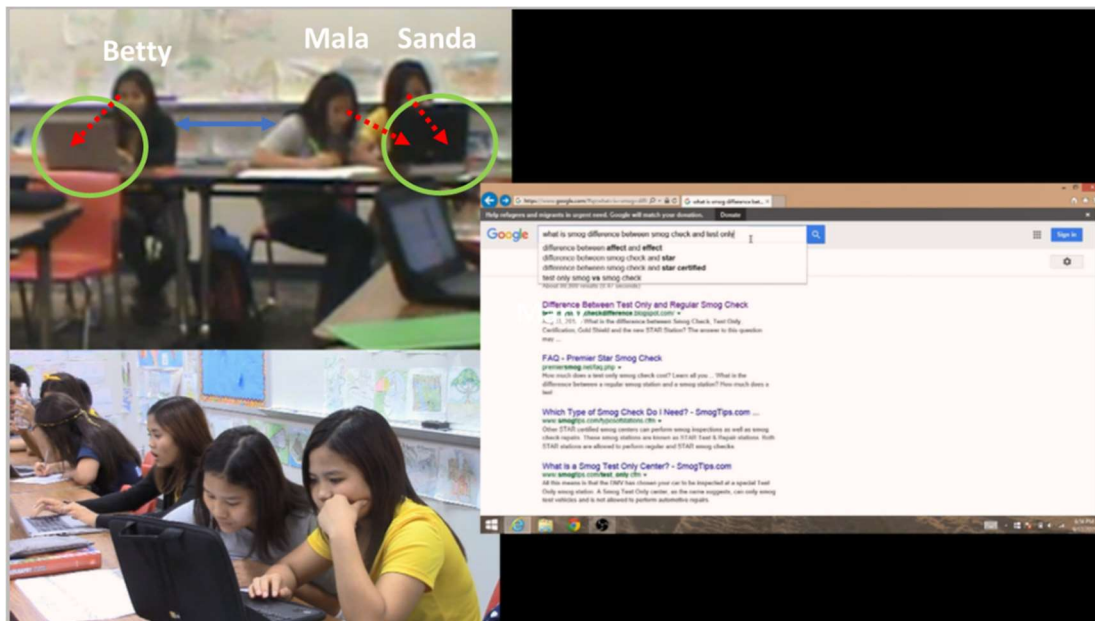
In this last example, we demonstrate the powerful use of screen capture data in understanding how learners engage with the computer and online resources. This event comes from Week 3 of 2015-16. In this session, learners were instructed to make small groups of two or three, select one of the questions that learners came up with in a previous session, do online research, and present their work to the whole group.

We turn our focus on Betty. In this snippet, Betty starts to work on her own because she had difficulty working with her original group that consisted of her and twins Mala and Sanda. Betty had a hard time contributing since the twins had monopoly of the worksheet and the computer. They were wanting to answer “What is the difference between smog and fog?” Wanting to do meaningful work, Betty asked the facilitators for a computer.

Some of the images in the Transcript 3 that follows show the two different camera angles as well as the screen captures of Betty’s computer work. On some images it focuses on one angle that captures Betty’s gestures and computer work. The same transcription convention was used as earlier.

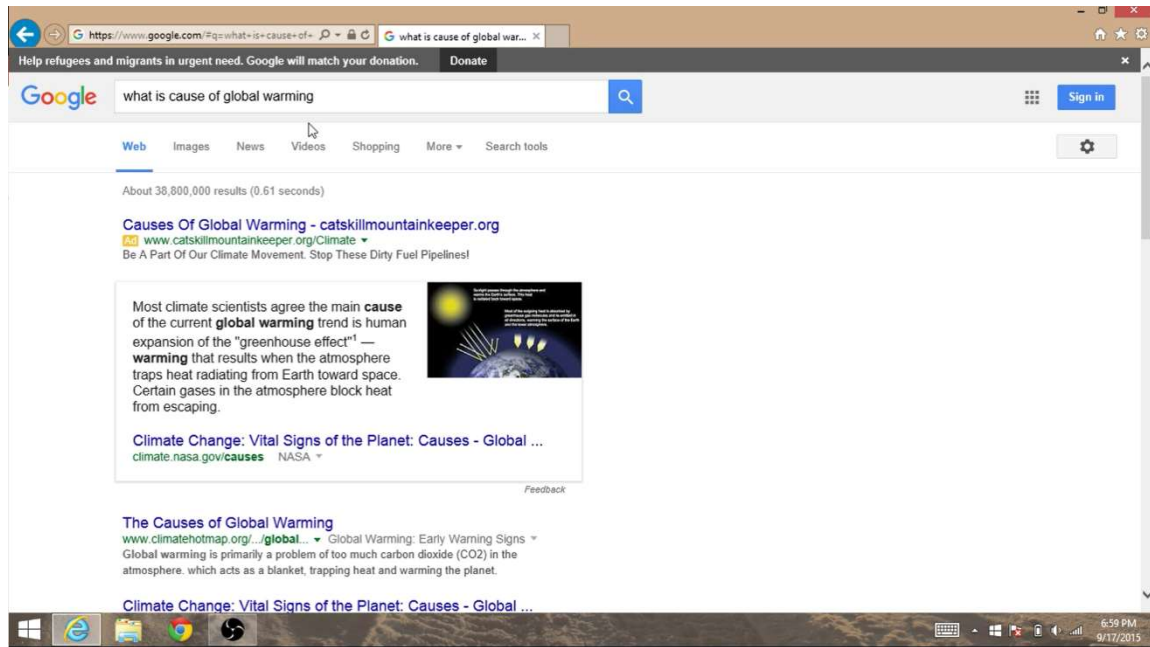
Transcript 4.3 Betty explains Global Warming

- 1 Betty sits a seat apart from the twins. On her screen, she types the keywords “what is smog” and the computer shows multiple suggestions.



Transcript 4.3 continued

- 2 A few minutes later, Betty asks for a new worksheet and changes the question she is researching into “What causes global warming?”. On her screencast, she searches for the keywords “what is cause of global warming”.



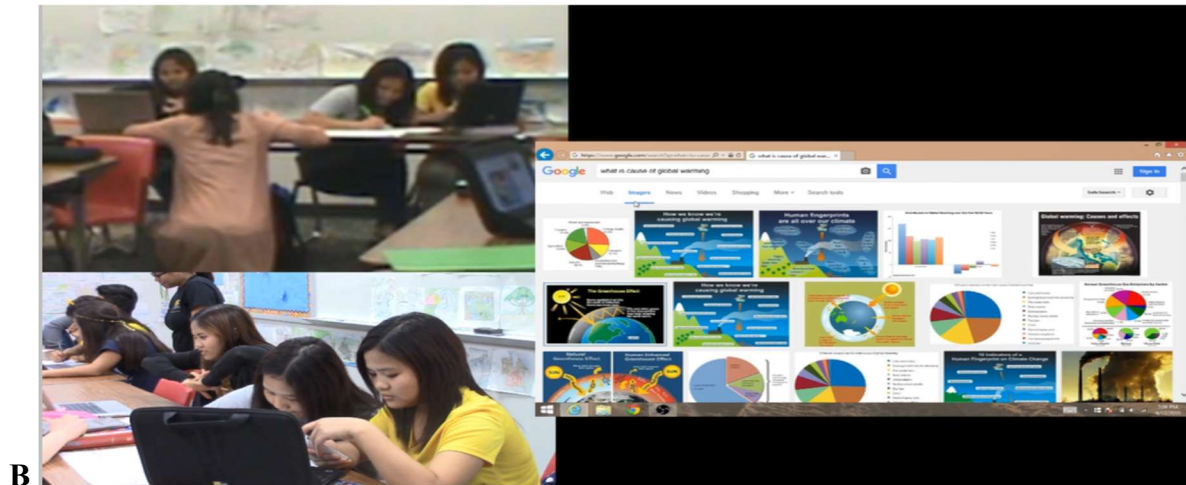
- 3 MJR approaches Betty to check on her. Betty tells her that she is working on her own and on a different question.
- 4 MJR: Global warming. Ah. What's your question? The cause of global warming. What is global warming?
- 5 Betty: Ah, is it uh (.) ((Leans closer towards the computer)) Like, like greenhouse? ((Smiles))
- 6 MJR: Uhuhmm. what is it?
- 7 Betty: ((Gaze directed towards the screen. Leans closer)) That results when the (.) at-mos-fer, I don't know (.) from from Earth toward space that's escaping in the atmosphere block^A

A



Transcript 4.3 continued

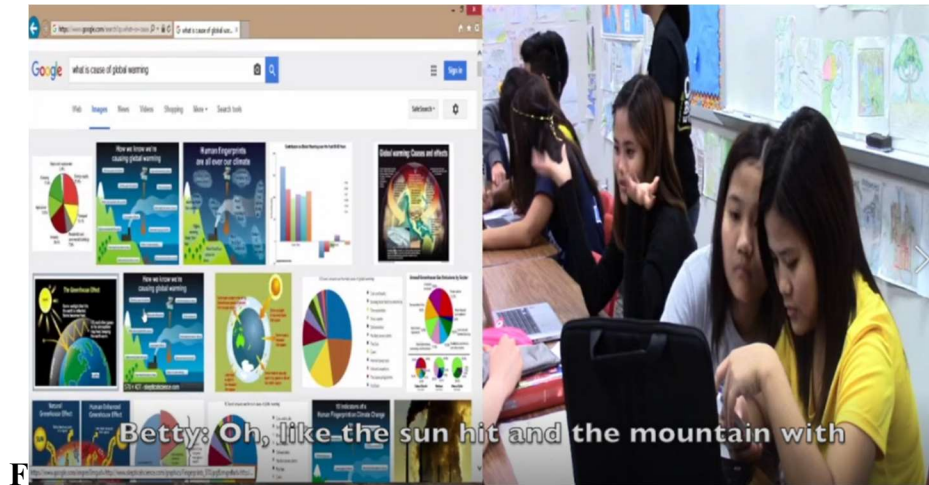
- 8 MJR: Uhuhmm, can you explain that to me? ((*Crouches down from a standing position.*))
- 9 Betty: Ah, I think that ah (hhh) ((*Computer action: Clicks on 'Images'. Moves finger around the mousepad*))
- 10 Betty: When like (.) it's common to B, (C-E)



Transcript 4.3 continued

11 Betty: I don't know ((Looks away from MJR and directs gaze towards the computer. Smiles))

12 Betty: ((Computer action: Moves the mouse around.)) Oh, like the sun^F het and the mountain^G with. No. Like the mountain^H in the ***^I with. I don't know^J.



G



H



I



J

13 MJR: Mountains and sun.

14 Betty: I think that like sun^K, earth, that like the het^L



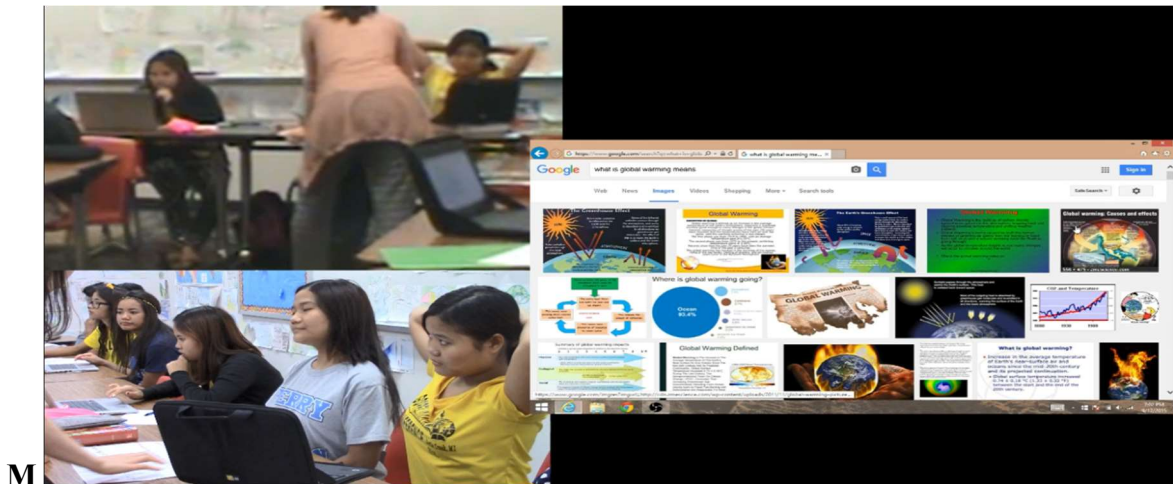
K



L

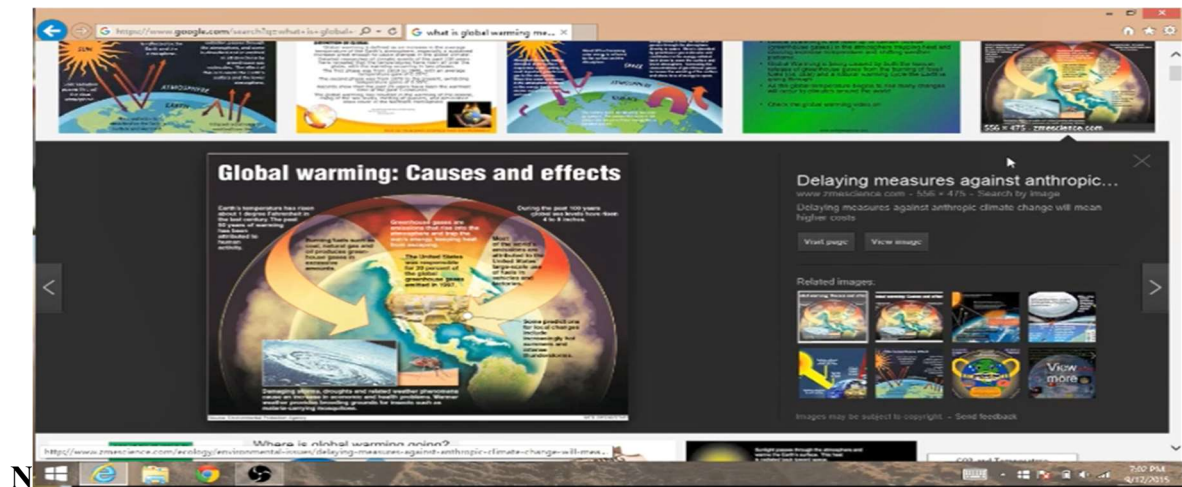
Transcript 4.3 continued

- 15 MJR: Oh sun will he:t? ((Makes a circular motion with the wrist))
- 16 Betty: Yeah.
- 17 MJR: Like the earth?
- 18 Betty: Uhuh
- 19 MJR: Okay
- 20 Betty: I think that's sure, but I'm not sure ((Turns her gaze to the computer. Moves her fingers over the mouse pad))
- 21 MJR informs Betty that there is another group working on the same question and gives Betty the option of joining them. Betty refuses saying that the other group is already working together. Betty points to the twins and tells MJR that "We are going to work together again"
- 22 MJR turns to the twins. Meanwhile, Betty changes her search keywords to "What is global warming means"
- 23 Betty spends a few moments intently reading the definition. She then switches to images. ((Mouse action: Moves across the images.))^M

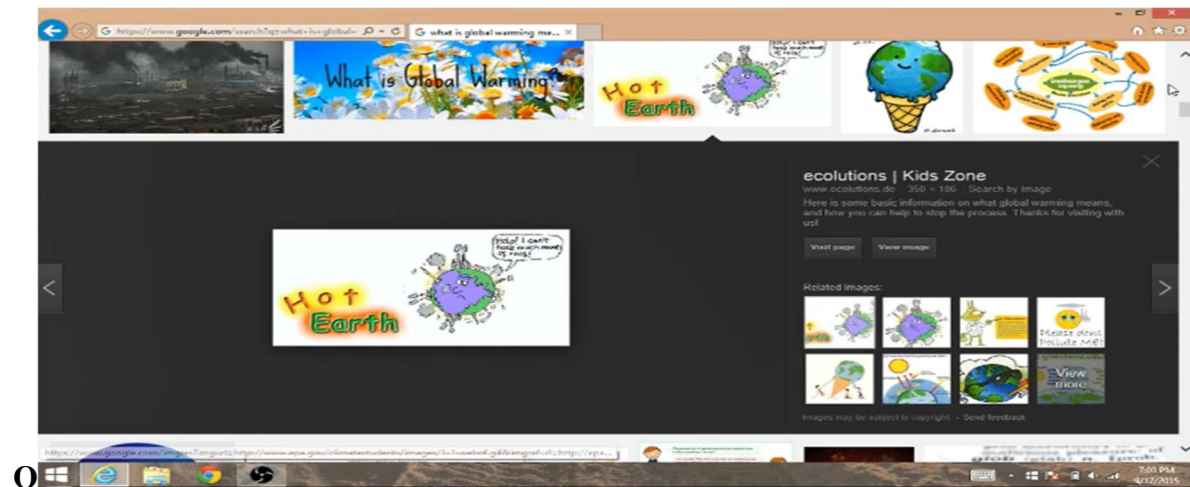


Transcript 4.3 continued

24 Betty clicks on an image.^N



25 Betty looks at other images. She clicks on an image.^O



Transcript 4.3 continued

26 Betty: ((*Turns towards MJR*)) Oh, I KNOW!^P I know the cause, is it hot^Q, hot^(R-S) earth?



27 MJR: Uhuh ((*Betty smiles*)) The earth is becoming hot.

28 Betty: Yeah ((*Betty nods, smiles*))^T



29 MJR: Global warming?

30 Betty: Uhuh

31 MJR: Yeah. That's very simple, you know, one of, like, explanation. Yeah.

This event captures Betty's persistence in engaging with the learning task. The episode starts with Betty feeling distant from her group members Mary and Shelly as she struggled to contribute to the sensemaking task (**Turn 1**). Despite having a computer and making an attempt to research about smog, Betty is unable to share her ideas. This would lead Betty to switching research questions and doing her research independently (**Turns 2-3**). Upon MJR's inquiry on her understanding of global warming (**Turn 4**), Betty's first attempt to answer MJR was to say "greenhouse" (**Turn 5**). However, MJR probes Betty further to elaborate on her idea (**Turn 6**) prompting Betty to read directly from the screen (**Turn 7**). MJR then asks Betty to explain (**8**).

In typical classroom settings, the norm has been that the instructor initiates a question, the learner responds and the instructor evaluates and moves on. This typical discourse pattern has been dubbed as Initiate- Response- Evaluation (I-R-E; Mehan, 1979). However, in the exchange between Betty and MJR (**Turns 4-8**), MJR does not move on but instead continues to probe Betty further. This is probably unexpected and Betty's audible inhale (**Turn 9**) seems to punctuate her

next step of switching to look at images. Betty's switching to images gives her another source of information especially when the text is hard to access. To demonstrate her learning, Betty attempts to articulate it with words (**Turn 10**) and gestures (**C-E**) but she has a hard time doing so (**Turn 11**). Then, Betty tries again this time switching to using gestures (**G-I**) to articulate her thinking (**Turn 12**). We posit that Betty's interpretation of global warming has undergone various transformations with her every attempt at engaging with the concept of global warming. Betty's attempts to transform the idea of global warming conveyed in language (text on the screen) and images (Google images) to language (Betty's speech) and gestures are ways in which Betty attempted to demonstrate her learning.

In **Turn 13** and only after Betty has attempted multiple ways of articulating her ideas, MJR repeats back what she has gleaned from Betty's attempts. Betty then attempts to make more precise gestures (**K-L**) and introduces "het" to her utterance (**Turn 14**). MJR repeats this back to Betty and asks if she meant that the "sun will he:t" (**Turn 15**) "the earth" (**Turn 17**), to which Betty affirms (**Turns 16, 18**). However, Betty remains uncertain (**Turn 20**) despite MJR's affirmation (**Turn 19**). Of note in this exchange is a point of contention that would be hard to resolve when focusing only on language alone. Betty's utterance of "het" and MJR's utterance of "he:t" could either mean heat (phonetic spelling: /hit/) or hit (phonetic spelling: /hɪt/). We take special note of this especially in exchanges in superdiverse settings where people speak many different languages and use world English with many different accents (Bamgbose, 1998). In this particular case, we argue that Betty meant "heat" based on how she uses the gesture in **Turn 13 (K-L)** and juxtaposing with her later gestures in **Turn 26 (Q-S)** with the word "hot". Thus, in this sense attention to multimodality gives us a better insight as to what speakers mean.

Discerning Betty's difficulty, MJR offers Betty the option to work with another group (**Turn 21**). Betty refuses and instead states that she will work with the twins again. From MRST's conversation with Betty in this session, Betty speaks the same ethnic language (Falam) as the twins. Since this is the first three weeks of the implementation, learners are still getting to know each other and most of the learners chose group partners from co-linguistic peers. Working with friends that speak the same language allows them to use the language they are most comfortable with in their discussions. Not having to use the language of display (Bunch, 2014), in this setting English, allows learners to instead spend more time on sensemaking.

Despite MJR turning to the twins and even after Betty has said she will work with the twins, Betty decides to continue to pursue the question about global warming (**Turn 22**). This demonstrates Betty's continued engagement on the learning task.

Betty searches for the meaning of global warming (**Turn 23**) and much like earlier in this episode, she switches to images as a meaning-making resource. Betty chooses an image (**Turn 24, N**) but decides on a different image (**Turn 25, O**) which shows the earth asking for help and the label "Hot Earth" (See **Figure 4.7**).



Figure 4.7 Close up of the image Betty used.

Photo credit: <http://www.ecolutions.de/73-1-Kids-Zone.html>

Finding the image and getting the information she needs is exciting for Betty and she makes it known with the stretch of her arms (**P**) and her exclamation of "I KNOW!" (**Turn 26**). Her proud smile (**Turn 28, T**) after MJR confirms her answer gave Betty a sense of accomplishment. Only then, does she regroup with the twins and start working on the question on the difference of smog and fog.

Betty's proud moment is especially interesting when juxtaposed with how Betty perceives herself in relation to science. In the conversation that MRST had with Betty after the learners' research activity, Betty says that "science is so hard" because "...we need to think how [things can] become and how [it occurred]. We need to think and we need to do it with on my idea so I

don't have idea." When MRST probed further, Betty replies that "I can't think like I keep thinking, but I can't do it" and then she gives the example of how she always gets Ds and Cs on science tests.

4.6 Discussion

This paper discusses our methods of data collection, processing, and analysis. Moreover, this paper demonstrates the value of employing multimodal interactional analysis in investigating learners' science engagement. We structure this section into three parts. First, we discuss the insights we glean from viewing engagement through multimodality. Second, we discuss the techniques we employed to help us arrive at multimodal evidences of engagement. Finally, we comment on our work process in conducting this kind of work.

4.6.1 Viewing engagement through multimodality

When we started analyzing RESET data, we naturally foregrounded talk-based approaches. However, our continued interactions with learners and the richness of our data corpus compelled us to find new ways of looking at our data and finally gravitating towards multimodal interactional analysis. Attention to multimodality enhanced our ability to communicate with one another and achieve learning goals. Even with the use of a common language in our interactions, attention to modes beyond language consistently enhanced sensemaking.

In formal school settings, multilinguality is often deemed as a deficit given that classroom instruction is traditionally rooted to English monolingual ideologies (Kibler & Valdés, 2016). In contrast, RESET sought to provide opportunities for meaningful sensemaking and we explicitly established a norm of having learners use the language that was most comfortable to them. This brought about several effects: first, learners engaged more in the science learning and second and more importantly, learners used other modes beyond language rather than be limited on articulating their ideas in English to communicate.

Because of learners' rich use of multimodality in the setting, we also rethought our approach on how engagement looks like. We found that when we focused on modes beyond language, engagement became visible through how learners coordinated space with one another (Example 1), how they used gestures (Example 2), and their use of images (Example 3).

In Example 1, attention to language alone gives limited insights to how learners give each other space to enact ideas. The audio recording only captured Thiri's utterances and painted a picture of her dominating the activity. Yet attention to how Thiri, Ei, and Nyein coordinated space with one another clearly shows the interaction to be more equitable. Although our analysis focused mostly on Thiri, Ei, and Nyein, other participants were also involved in the interaction although their participation may have been silent. These insights would not have been possible if we relied on talk-based approaches alone.

From this analysis, we were compelled to pay more attention to the *silent* participation of our learners. Ryu (2015) argues that reticent learners were relationally positioned to be of lower status due to their non-participation in discursive practices of the classroom. In this work, we can reimagine the possibilities of what science engagement looks like for reticent learners. We have compelling evidence that silence does not mean lack of participation.

In Example 2, our analysis showed the embodied knowledge youth constructed of “muggy”. This knowledge goes beyond expressing “muggy” as a vocabulary term but expressing the experience of it, as indicated by Mya's gesture of how sticky feels like. In this sense, learning is demonstrated by way of making connections between an unfamiliar word, their experiences of stickiness, and the concept of humidity. Attention only to language alone would instead have us hearing learners shouting out answers that appear to be disjointed amidst the laughter. For example, Sandi's statement of “That's my bus” would not have made any sense had it not been for Mya's gesture of perspiration streaming down her face – a connection that her peers could relate to and decipher. Thus in this case, the combination of both Sandi's utterance and Mya's gesture makes their construction of meaning visible through connecting authentic experiences with an unfamiliar word. It could also be argued that Mya's gestures provided learners a way to relate to the experience of “muggy” and thus imparted learning to her peers. In addition, Thiri's gesture in mixing of two incompatible ideas helps other learners bridge concepts and signals to the group that she is trying something new. In this sense, Thiri's initial gesture is generative in encouraging other learners to take risks and try out uncertain ideas.

From this analysis, we see a new meaning of what an ensemble of mode may look like. Traditionally, as applied by Norris (2004) wherein her ethnographic subjects are usually individuals or pairs, the ensemble of modes usually referred to the combination of the modes as performed by a single individual. Here, in our analysis, we see two different individuals (Sandi

and Mya) co-constructing an ensemble of mode to make meaning for an even larger audience. In this sense, our analysis demonstrates that especially for multilingual learners the ensemble of modes take on new meaning and is leveraged strongly in sensemaking moments.

In Example 3, attention to language alone would give us a very limited understanding of how Betty was engaging with the task. The ability to view how Betty shifted from text to images and her selection of images shows how she was thinking through the process. We saw how Betty built meaning through her gestures when English was masking and mediating what she knew about the topic. We saw her discerning what was relevant information as she repeated words that she saw from the images.

We also see witnessed how Betty sustained her engagement in her goal of figuring out global warming. We view this incident as especially helpful in making us be more reflective on our teaching and facilitation moves. From our analysis of Betty's resilient moments in her engagement in science learning, we realized that we needed to give learners more opportunities to have these proud moments of accomplishment and not overlook their engagement when they are having difficulties in articulating ideas using a language of display.

4.6.2 Insights Regarding Our Way of Multimodal Interactional Analysis

Multimodal Evidences of Engagement

In our analysis, we sought to look for multimodal evidences of engagement. We utilized Engle and Conant's (2002) framework on what greater engagement looks like. In our analysis we looked for modes that take on high intensity or high complexity (Norris, 2004). According to Norris (2004), a mode takes on high intensity when other modes are structured by this mode. We see this in example 1 where the coordination of proxemics structures the other modes of gesture, posture and gaze. Due to the coordination of space, the learners were able to contribute in the accomplishment of the task. More importantly, their contributions were not made singly but collectively; and their engagement was sustained over an extended period of time. By Engle and Conant's (2002) parameters, this coordination of space showed greater engagement.

A mode can also take on high intensity when all embodied modes of an *individual* are focused upon this one mode (Norris, 2004). In example 3, Betty's posture, gaze, and gestures were focused on the use of images and through the coordination of this ensemble of modes she was able

to move towards accomplishing her goal of explaining greenhouse and sustain her engagement. Once again, by Engle and Conant's (2002) measure, these are evidences of Betty's greater engagement.

Finally, a mode can take on high complexity when there is an interplay of many different communicative modes (Norris, 2004). We were able to capture this in our analysis of Example 2 wherein the interplay of Sandi's speech and Mya's gesture regarding the bus contributed towards greater sensemaking of how the bus connects to the concept of humidity. Through Sandi and Mya's co-construction, greater engagement was achieved by: a) the both of them making substantive contributions towards defining the word muggy; b) coordinating with one another; c) being on-task to achieve their learning task; and c) sustaining involvement towards the task – not just theirs but also their peers (Engle & Conant, 2002).

Use of Different Transcript Formats

Following Norris' (2004) suggestion, we transcribed each mode individually. However, we took the liberty of using different transcript formats depending on the analytical focus. This is in keeping with the stance that modes can be subordinate or superordinate in different contexts. Thus, the use of a transcript format that shows what modes are emphasized at certain moments affords us to attend to the intensity and complexity of the modes. We demonstrated this by the use of still images to show lay-out, annotations to show changes in the modes, and finally the gesture cut-outs to show movement. Though various researchers use different ways of doing multimodal transcription (e.g., Hampel & Hauck, 2006; Baldry & Thibault, 2006; Norris, 2006), our use of a flexible transcript format for our purposes affords us the ability to view which mode is foregrounded in each moment. Through this, our analysis is more nuanced since we account not only for what modes are utilized in the moment but also the variation of intensity and complexity – and thus modal density. In this way, beyond understanding what modes constitute an interaction, we also glean insights as to the importance of the particular modes in the interaction.

Use of Multilayered Videos

Our analysis necessitated the creation of multilayered videos. While this is not a new technique, our utilization of this technique affords us a snapshot of all salient data sources. By

salient data sources, we refer to all data sources that could possibly have bearing to our analysis. We differentiate this from the traditional use of synced data sources where it is confined to only the camera angles. Our creation of multilayered videos affords us a way to include subtitles and images of artifacts. In this way, this allows us the flexibility to look at the individual as well as the ensemble of the data. This is particularly important especially since we dealt with a lot of data that had to be translated. While we do not wish to diminish the value of a written transcript, the addition of translated subtitles affords us the ability to juxtapose translated utterances to the other modes of gesture, gaze, posture, etc. in real time. We believe this gives us an advantage in how we conduct our analysis.

An additional but a less obvious benefit of the creation and use of multilayered videos is the ability to choose audio sources. Since we used multiple audio-recorders we were able to reconstruct moments that though were video-recorded were not the focus of the audio-recording attached to the video file. We also had an extreme example where we were able to salvage and utilize poor quality data. We once ran into a challenge of having one of our microphones run out of battery that it caused one of our video recordings to lack an audio track. But because we had other audio sources, we were able to reconstruct the moment by layering the video with the audio track from a different audio source. Thus, the use of multilayer videos is not only beneficial to analysis but also addresses issues that may come up in the data collection.

4.6.3 Working with Multimodal Interactional Analysis

Importance of Collaboration

An important aspect of our methodological approach is the collaboration. In our work flow, certain tasks were delegated to individual members of the team but the selection of events for close analysis and microanalysis was a collective effort. We started with a whole-to-part approach as suggested by Erickson (2006) wherein all the members of the team undertook multiple viewings to reach consensus on the events, transitions and themes. This was necessary to ensure that our interpretations of the interactions were not only grounded in several other data sources but also that different perspectives were taken into account. Each of the research team member brought experiences and expertise in the research endeavor. The multiple iterations of the analysis process also ensured that our interpretations are valid.

Use of Organizational Tools

Since our data collection was complex, we utilized task lists and created a data management system to keep us on track with our research objectives. The task lists were especially effective in reminding us of what we needed to do while we were on the field as well as to organize the logistics of each data collection. We used Excel to log all of our data and inform research team members of what processing has occurred with specific data.

Use of Technology

Another key element in our approach was the use of various technologies. We relied on platforms such as Handbrake, PURR, as well as Google Doc to share data and analytical notes across research team members. Sharing of analytical notes via Google Doc was especially useful in working synchronously and asynchronously. For example, members of the research team can access and comment on the analytical note as it is being written.

The combination of the tools that we used – Inqscribe for transcription and Camtasia for rendering multilayer videos – in generating our multimodal transcript was effective in meeting our research objectives. Our first objective was to nuance the modes and we were able to accomplish that through paying attention to each mode, transcribing, and when salient taking still images of layout/gestures/movement.

4.7 Conclusions

In this paper we outlined our approach in analyzing youths' engagement via multimodal interactional analysis. This approach includes undertaking ethnographic data collection and use of various technologies to generate multimodal transcripts. We suggest that a multimodal approach in looking at youth's science engagement is especially useful when working with traditionally minoritized learners whose contributions may be rendered invisible when focus is on verbal participation alone. Viewing multimodality via multiple modes can give us richer insights into the learning processes as well as in the design of learning environments that can foster youths' science engagement.

CHAPTER 5. HOW DO MULTILINGUAL LEARNERS USE MODES BEYOND LANGUAGE IN NEGOTIATING THEIR PARTICIPATION?

A version of this analytical chapter will be submitted for publication. *Authors: Mavreen Rose S. Tuvilla, Purdue University and Minjung Ryu, University of Illinois- Chicago*

Abstract: Most science learning literature focuses on language yet close attention to the situated interplay of communicative modes (speech, image, gesture, gaze, etc.) reveals richer insights on the dynamism of learning interactions. This study uses multimodal interactional analysis to examine interactions of resettled Burmese refugee youth as they learned about climate change in an afterschool science setting. We identified the ways focal participants used speech, proxemics, coordination of material resources, gestures, and images in their participation. Here we posit participation as a negotiation of interactions and manifested in how youth negotiated their group membership, task roles, and cognitive authority. Findings offer insights on how learners negotiate participation in learning practices and can potentially help educators design more inclusive and equitable approaches to science instruction.

5.1 Introduction

Reform-based science curricula in the U.S. strongly encourage students to engage in practices that emphasize scientific argumentation (National Research Council [NRC], 2012). Participation in science practices such as arguing from evidence, providing explanations, developing models, and communicating information are construed as language intensive (Next Generation Science Standards [NGSS], 2013). Thus, there appears to be an explicit assumption that for a student to be successful, the learner must demonstrate verbal participation, both oral and written, as evidence for science learning.

We question this traditional view that participation in science learning is a primarily linguistic accomplishment (Lemke, 1990) for three reasons. First, emergent bilingual and multilingual students may not yet have developed sufficient English proficiency to be able to participate in such linguistic practices of science. Yet policies that impact English language learners (ELLs) equate English proficiency with academic proficiency (World-class Instructional Design and Assessment [WIDA], 2007). This is evidenced by the emphasis on structured English immersion that forces students to learn subject content only in English and often disregards the development of students' home language (Lee, 2005). Thus, acquiring oral and written English

and exit from English as a Second Language (ESL) and English for Speakers of Other Languages (ESOL) programs becomes the default determinant of science outcomes (Lee, 2005). As changing migration patterns and globalization reshape our social, political, economic, and educational landscapes, our classrooms are moving towards superdiverse conditions (Gogolin & Duarte, 2017) where linguistic superdiversity is the norm (Enright, 2011). In this context, language-heavy science practices may jeopardize learning and participation of emergent bilingual and multilingual students.

Second, the expectation that learners engage verbally to demonstrate learning is rooted in western cultural assumption about the relationship between talking and thinking. Kim (2002) found that people of Asian descent place high value in quiet introspection and internal speech; thus, verbalization of Asian Americans' thought processes were detrimental to their performance in cognitive tasks. In addition, a study by Roberts and Rogoff (2012) demonstrated that bilingual Mexican-heritage US children communicated not only through talk but "with their eyes and their hands" (p. 88). While Anglo children emphasized the use of spoken words as necessary for communication, Mexican-heritage US children expanded how they perceived talk and included nonverbal communication such as gazing, nodding, pointing, and gesturing (Roberts & Rogoff, 2012). These studies imply that blanket emphasis on verbal participation for science learning may marginalize other non-verbal forms of participation (Ryu, 2015). Third, there is a reason to suspect the very assumption that puts a strong emphasis on verbalization in doing science. The science learning setting promotes the frequent use of apparatus, models, animations, images and actions (Kress, Jewitt, Ogborn, & Tsatsarelis, 2014). Attention to language alone may fail to capture how students manipulate apparatus, use images, actions, and speech as they engage in the learning processes embedded in the moment of interactions

Recently, the NGSS has seen a shift in interpretation from promoting language-intensive practices towards disciplinary practices that promote multimodal ways of engagement in learning (Grapin, 2019). This *multimodality* views communication and representation as an interplay of the full range of communicational *modes* such as language, image, gesture, gaze, posture and so on (Jewitt, 2014), and taking all modes as important and not merely embellishments to language (Norris, 2004). With regards to teaching STEM subjects for English learners, a recent report promoted transformations in teaching for ELLs to draw on their multicompetencies which include all of their languages and the various modalities for meaning-making (National Academies of

Sciences, Engineering and Medicine, 2018). We view this emphasis on multimodality as a necessary shift towards providing a more optimal STEM learning experience for all learners in the changing US educational landscape.

Our research participants are resettled Burmese refugee youth, mostly born in Chin State, a mountainous northwestern region of Myanmar (also known as Burma). These youths are multilinguals who speak two or more Chin ethnic languages (e.g., Hakha, Falam, Zophei, Mizo, etc.) and are or have been English language learners. While youth of refugee backgrounds are traditionally marginalized due to their status as refugees and as ethnic and linguistic minorities, this particular group of resettled Burmese refugee youth have reported struggles with participating in school due to their perceived language barriers (Ryu & Tuvilla, 2018). We argue that this is not merely a language problem but a limitation on how engagement is currently conceived in schools where non-dominant learners' scientific contributions are rendered invisible (Luykx, Lee, & Edwards, 2008). Thus, one of the main premise of our work is that learners engage in learning in ways beyond the mode of language. Building on this assumption, we attempt to expand the idea as to what it means to engage in science by approaching participation in science learning practices through the lens of multimodality and offer insights into how youth agentively use multiple modes in science learning practices.

In this work, we ask: *How do multilingual learners use speech, proxemics, coordination of material resources, gestures, and images in negotiating their participation?* This study presents a multimodal interactional analysis of video- and audio- data from an afterschool science program to demonstrate various ways resettled Burmese refugee youth utilized multiple communicative modes (speech, image, gesture, gaze, etc.) to negotiate their participation in learning practices. We are motivated to examine multimodal engagement with a particular focus on resettled refugee youth since much of current research have ignored the unique needs of refugee youth (Matthews, 2008). Moreover, the few research on the experiences of resettled refugee youth take a homogeneous view on youth of refugee backgrounds (Taylor & Sidhu, 2012). Studies do not account for their pre-migration histories and post-migration issues (McBrien, 2005; Rutter, 2006) and focus mostly on English language acquisition (McBrien, 2005) and mental health and traumatic experiences (Lustig, et al., 2004). In our perspective, it is not sufficient because these studies do not address how refugee youth fare in disciplinary content areas such as science (Faircloth & Tan, 2016). Therefore, our study attempts to advance knowledge in how resettled

refugee youth participate in learning practices and learn subject area content, particularly in science. We note that our work is situated in informal contexts. Informal learning environments provide opportunities for learners to engage in science meaningfully and comfortably (Leonard, Chabberlin, Johnson & Verma, 2016). We hope that by understanding what fosters learners' comfortable engagement in science our work can contribute to the transformation of educational environments for minoritized youth.

5.2 Conceptual Framework

This work seeks to expand ways of viewing participation through attending to multimodality. We start by explicating our views on participation and unpack our perspectives on the constructs of interaction, negotiation, and multimodality and discuss how we operationalize these constructs in our work. To guide readers, we present a conceptual map of our framework in **Figure 5.1**.

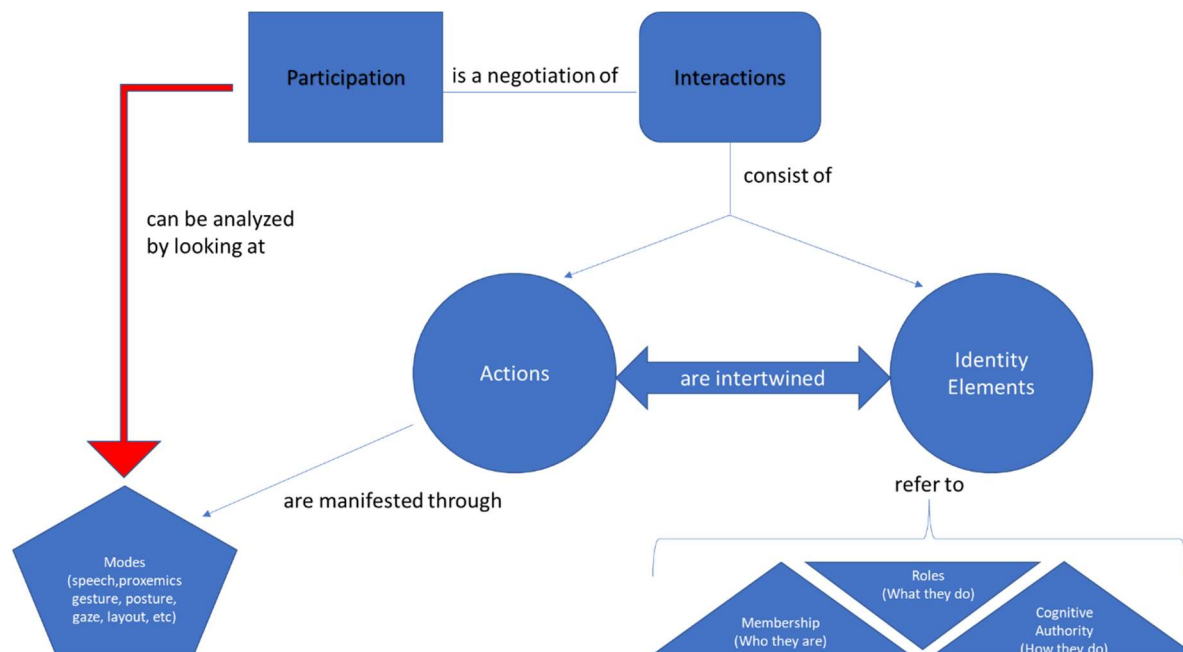


Figure 5.1 Conceptual Map

5.2.1 Participation

Lave and Wenger define *participation* as the socially situated process wherein individuals become increasingly more able in the ways of a community manifested through *practices* and through repeated *interactions* with more experienced members of the community (Lave & Wenger, 1991). We build on this situated perspective on participation and expand it in terms of its scope. Scollon (1998) argues that participation is a negotiation between actors on how they relate to each other, how they interpret the event in which they participate, and their respective identities in those events. Thus, in a sense participation is a negotiation of interaction wherein actors negotiate how they relate towards one another based on their actions and the identities they bring. Whereas Lave and Wenger's (1991) introduces us to how we may view the process as a whole, Scollon's (1998) perspectives clarifies how the process of participation occurs in the negotiations between individuals that take place in the events. Norris (2011) expands the common use of interaction and refers to it as (inter)action to emphasize that interactions includes all actions that actors produce with tools, the environments, and other individuals. We apply Norris' (2011) expanded redefinition of interaction in our work and account for the actions learners engage in not only with their peers and facilitators but with the material artifacts (the tools they use) as well as the layout of the setting. This broadened definition of interaction is important in our attempt to capture how learners holistically interact in the afterschool science program. In sum, we view participation as the ways wherein learners negotiate the multiplicity of their (inter)actions within the afterschool setting.

5.2.2 Action and Identity Elements comprise Interactions

Norris (2011) posits that participation is a negotiation of *action-identity elements* that occur in interactions. In viewing *actions*, we take inspiration from Goffman's (1959) use of theatrical performance as a metaphor to understand Norris's (2011) arguments on how action and identity are intertwined within interactions. According to Goffman (1959), performance refers to the activities an individual engages in as observed by co-actors that somewhat shape co-actors' subsequent actions. In Goffman's (1959) perspectives on performance, he remarks that the "setting" (e.g., furniture, physical layout, etc.) and "personal front" that includes insignia or markers of rank, clothing, looks, and modes (e.g., speech patterns, facial expressions, gestures, etc.) are important but distinct parts of a performance. We pay particular attention to the modes as

these elements are dynamic and co-constructed with other actors in an interaction (Scollon, 1998); whereas other characteristics such as setting, insignias and clothing are more permanent in the micromoments of interaction. Hence, in our work, we attend to the learners' performance as exhibited by their actions. We do so because actions are observable in interactions. Actions are always performed by one actor and then interpreted or given a meaning by the interactor (Norris, 2011). Moreover, actions and identity elements are intertwined wherein "action always is identity-telling and identity is always produced through action" (Norris, 2011, p.53). In other words, meaning resides in the interaction, or the give-and-take, wherein one actor performs an action, and the interactor interprets the action in identity terms (Norris, 2011).

In our analysis of interactions, we view identity elements between actors in terms of: 'who they are', 'what they do', and 'how they do' in the moments of interaction. This is in line with Norris' (2011) view of identity as a process that is always negotiated, always developing in the moment, and never static. We point out that this notion is in keeping with Holland and colleagues' (1998) perspectives of identity as being co-produced by those involved in the interaction.

In our work, we denote identity elements in terms of negotiations of group membership (who they are), roles (what they do) and cognitive authority (how they do). *Group membership* refers to the social relationships that connect two or more individuals in a group (Forsyth, 2014). There are two popular theories on the nature of what determines group membership. An earlier theory is the Social Cohesion Model which stresses the affective nature of the relationship wherein there exists social or psychological interdependence among group members to satisfy goals as well as validate attitudes and values fostered by the group (Turner, 1981). A second theory is the Social Identification Model which comes from a cognitive perspective and argues that membership is determined by social identification or the perception of the members of being in the same social category (Turner, 1981). For our purposes we borrow from both theories and define group membership to be determined through interactions between two or more individuals who identify as belonging to a group and are working towards a similar purpose or goal.

Roles refer to the behaviors expected of members who occupy different positions in a group (Forsyth, 2014). Roles are greatly influenced by the group structure as well as the norms and intermember relations that govern a group (Forsyth, 2014). While there are groups that have pre-established norms and rules with defined task roles and expectations from each member, this work focuses on self-organizing groups in an afterschool setting wherein the group structure and norms

are emergent and less defined. Hence, the roles, norms, and communication patterns are established through interaction within the group and with other actors (e.g., facilitators and peers). This points to a mechanism of self-organization, an adaptive process wherein the group adapts to its environment through changes in its structure and organization (Forsyth, 2014). The groups in this study were created to fulfill a certain task (e.g., research a climate-related topic) and thus, fulfillment of the task is the group's main concern (Argyle, 1983). In such a case, the group adapts by ensuring that it accomplishes the task most effectively by balancing the group goal as well as the group members' individual goals (Gergen, Greenberg, & Willis, 1980). Hence, in this work we subscribe to a functional distribution of task roles (Stempfle, Hübner & Badke- Schaub, 2001). Functional task role distribution refers to how a group collectively assigns specific roles to individual members to ensure competently accomplishing the goal (principle of competence) and such that as many group members as possible are assigned tasks that they themselves prefer (principle of preference) (Stempfle, Hübner & Badke- Schaub, 2001).

Cognitive authority refers to the power given to or taken by an individual whose ideas are taken up as “expert” knowledge (Stroupe, 2014). We hold that in any action, ideas are the precursor of ‘how we do’ and cognitive authority determines what value judgments are pursued and eventually what actions are undertaken. Cognitive authority offers a useful framework for explaining how individuals make judgements about the authority of the information in terms of whether it is “useful, good, current and accurate” (Rieh, 2002) Cognitive authority implies two things: first, a hierarchy is created when there is a division of cognitive labor, wherein knowledge is created or constructed; and second, the person with cognitive authority determines what knowledge is developed and communicated (Stroupe, 2014). In this sense, the negotiation of cognitive authority is an authentic act of argumentation wherein it fosters scientific thinking and helps the youth wrestle with scientific ideas as they construct them (Osborne, Erduran, & Simon, 2004).

5.3 Participation is a negotiation of interaction

We note that our classification of identity elements is somewhat reminiscent of Wenger's (1998) conception of a community of practice. We posit that the process of as an individual becoming a participant in a community of practice - involves the negotiation of who they are, what they do, and how they do. Wenger (1998) refers to the process of interaction with more

knowledgeable others as *legitimate peripheral participation*. Wenger (1998) elaborates that newcomers' actual participation are only possible when learners obtain *peripherality* and *legitimacy*. *Peripherality* refers to "a way of gaining access to sources for understanding through growing involvement" (Lave & Wenger, 1991, p.37). *Legitimacy* refers to the opportunities for learning granted to members that allow for "inevitable stumbling and violations" as they develop into fully participating members (Lave & Wenger, 1991, p. 101). Peripherality implies that learners can occupy various positions in a community of practice, often changing over time. Gaining legitimacy depends on how the social relations of power are negotiated (Leki, 2001). Hence, legitimate peripheral participation always involves negotiation of social structures and power relations.

Morita (2004) contends that negotiations of social structures and power relations involve "struggles over access to resources, conflicts and negotiations between differing viewpoints arising from differing degrees of experience and expertise, and transformations of a [learning community's] practices" (p. 577). Negotiations go beyond "assuming that [learners]...behave according to their abilities or cultural/personal preferences" (Morita, 2004, p.598). Negotiation involves the interplay of roles and statuses attributed to learners and how these roles and statuses influence and are influenced by interactions in the setting (Morita, 2004).

Status refers to the "agreed-on rank order where it is generally felt to be better to be high than low rank" (Cohen, 1994, p. 23). Status reflects how learners participate in a setting (Cohen, 1994). In small group interactions, status plays a crucial role in terms of productivity and learning outcomes (Cohen, 1994). Cohen (1994) argues that productivity in learning tasks are reflected in how frequent equal-status interactions occur and/or if there is little difference in participation rates between learners of different statuses. Learners with low status interact less often and wield less influence than higher status learners (Rosenholtz & Wilson, 1980; Tamivaara, 1982). Stated according to Lave and Wenger's (1991) community of practice framework, as learners become fully participating members, they interact more and gain status. The corollary is also true in such that as learners gain status in the community of practice, they interact more and become fully participating members. For our work, the directionality is less important compared to how status and interaction relate to one another. Rather, for this study we are more interested in how participation and statuses are negotiated.

In learning settings, academic status is the most powerful status characteristic due to its relevance to classroom activities (Mc Auliffe, 1991). For example, good students are better regarded as leaders compared to being White or male (Mc Auliffe, 1991). Peer status is differentiated based on perceived attractiveness or popularity (Webster & Driskell, 1983) where popularity is highly correlated with academic status (Rosenholtz & Wilson, 1980). In addition, social status determined by race, gender, and ethnicity also affect learners' interactions, wherein race and ethnicity often correlate with academic status (Cohen, 1982).

5.4 Interactions are multimodal

Interactions are inherently multimodal (Norris, 2004). People communicate in ways beyond spoken language. We instinctually take cues on the layout, through gaze, images, body positioning, etc – modes which are beyond spoken language. This ability to use all modes available to communicate is referred to as the translanguaging instinct (Wei, 2018)

Traditional classroom research promotes the idea that teaching and learning are primarily linguistic accomplishments (Lemke, 1990). Thus, most educational research studies focus mainly on language and thereby analysis of *spoken* discourse (Kelly, 2007; Kelly & Chen, 1999; Kiemer, Gröschner, Pehmer & Seidel, 2015; Smart & Marshall, 2013). However, the field of social semiotics has challenged this view. In particular, O'Halloran (2007) has been staunch in insisting that “the study of linguistic discourse alone has theoretical implications which have the potential to simplify and distort the actual nature of pedagogical practice” (p.79). Therefore, we approach this work by tapping into social semiotic approaches to educational research (e.g. Jewitt, 2008; Jewitt & Kress, 2003; Jewitt, Kress, Ogborn, & Tsatsarelis, 2001; O'Halloran, 2000; Unsworth, 2006). In doing so, we expand our ways of understanding multilingual learners' interactions. By evaluating the entire range of modes utilized in the afterschool space, we attempt to make visible the ways linguistic minorities participate in learning processes beyond spoken discourse.

5.5 Participation as Use of Various Modes

In our attempt to capture how minoritized learners exhibit their participation beyond spoken language, we adopt the broader definitions on multimodality adopted by the science education community. According to the differentiation made by Grapin (2019), the prevailing view in the

science education community is *strong multimodality* that accounts for both linguistic and non-linguistic as meaning-making resources (NRC, 2012; New London Group, 1996). Meanwhile, the dominant view in EL education is weak multimodality wherein nonlinguistic modes are only seen as supports for language development. This distinction is especially important since the contributions of minoritized learners are often rendered invisible (Luykx, Lee & Edwards, 2008). By expanding the view that nonlinguistic modes are legitimate meaning-making resources and not merely “illustrative supports to the real thing” (Kress, Jewitt, Ogborn, & Tsatsarelis, 2014, p. 51), we can reimagine the possibilities and question the implicit limits imposed on minoritized learners. In this work, we include the nonlinguistic modes of proxemics, posture, gesture, gaze, layout and other modes such as use of material resources and/or use of images. In what follows, we discuss each of these modes in detail.

Proxemics refer to the evaluation of how people use space in different contexts (Hall, 1963). This involves observation of proxemic behavior exhibited through interpersonal distancing, body orientation, and gaze alignment (Hall, 1966). Researchers have posited that proxemic behaviors can reveal the attitudes and motivations in an interaction and indicate the nature of the relationship between interactors (Argyle, 1975; Burgoon & Jones, 1976; Mehrabian, 1968, 1969). Beyond hinting about the relationship of interactors, spaces in itself are culturally and communicatively defined. Spaces take on different meanings depending on how they are represented (e.g., perceived and talked about) and by the nature of actions and interactions that take place in those spaces. For example, the front of the classroom is usually utilized as an authoritative space wherein when one is standing in front (e.g. the teacher), it becomes a position of power that communicates to the audience (e.g. the learners) that attention is required (Lim, O’Halloran, & Podlasov, 2012). Thus, when looking at individuals’ actions, proxemics play a key role in understanding the individual’s status in that particular interaction.

Posture or body position are ways by which one configures their bodies in an interaction (Norris, 2004). When observing an interaction, we gain considerable insight as to who the action is directed to when looking at the positioning of the extremities and the directional positioning of the body. Dittman (1987) describes an open posture as when the position of the legs and arms are apart and the knees are open, whereas a closed posture is when the arms are crossed/folded and the legs are crossed. Open and closed postures as well as the directional position of the body can vary in degrees because postural behavior is culturally habituated just like proxemics (Norris,

2004). Studies also show that expansive postures correlate with dominance (Hall, Coats, & LeBeau, 2005; Weisfeld & Beresford, 1982). Findings show that being in high-power roles lead to expansive body postures (Leffler, Gillespie, & Conaty, 1982), individuals who adopt expansive postures often act dominantly (Carney, Cuddy, & Yap, 2010) or are perceived by other individuals to be powerful (Carney, Hall, & LeBeau, 2005). Thus, examining postures can give us insights as to the perception of status in an interaction.

Gestures describe the movement of hand/arm, head, and other parts of the body to communicate (Goodwin, 2003). Kendon (1978) describes gesture as a “deliberately expressive movement [with] a sharp boundary of onset...and seen as an excursion, rather than as a result in any sustained change of position” (p. 69). The meaning of a gesture can be interpreted by looking at the gesture holistically and in parts in such that gesture can construe many different meanings (McNeill, 1992). For example, the raising of the hand in a wave may look like the raising of the hand in a blocking gesture to defend one’s self. Unlike language wherein parts of a language (e.g., morphemes, words, etc.) can be meaningful, the parts of a gesture may not have an independent meaning and thus must be studied in their full contexts (Norris, 2004). Some gestures co-occur with language, others do not coincide with language, while other gestures can co-occur but depict a different message from the occurring language (Norris, 2004). Gesture when combined with speech can work in a “reciprocal” relationship (Kendon, 2004, p. 174) wherein the gesture and speech work together to add specificity to an intended meaning. In other cases, gesture and speech may do different things. Therefore, gestures convey affordances that are unique to it that language alone cannot provide (Bezemer, 2014). Bezemer (2014) provides an apt example for when a surgeon points to a tissue that needs to be cut by his assistant. Even if the surgeon refers to the tissue by a particular name, the assistant would still need to know where exactly the tissue needs to be cut, thus the only way for the surgeon to convey his intended meaning with specificity is point it out with a gesture.

Gaze. Gaze refers to the way people organize and direct the positioning of the head, particularly the eyes, in reference to their environment (Goodwin, 1981). Goodwin (1981) showed the importance of gaze in interaction by studying conversations in a variety of settings. Goodwin focused on mutual gaze and repair structures (actions employed by interactors to address problems in speaking, hearing, and understanding; see Schegloff, Jefferson, & Sacks, 1977) within spoken language and concluded that co-participation and repairs are made possible due to gaze. Kendon

(1967) examined the gaze patterns of hearers and speakers and found that hearers directed long gazes at the speakers with brief moments of looking elsewhere at intervals. Meanwhile, speakers spend an equal amount of time directing their gazes towards and away from the hearer with a tendency to look towards the hearer at the end of phrases. According to Kendon (1967), gaze functions as a way to monitor and regulate an interaction wherein the succeeding action of a speaker is contingent upon the gaze of the recipient. Studies by Goodwin (1981) and Kendon (1967) suggest that gaze is sequentially structured and somewhat subordinate to language. However, Norris (2004) cautions that gaze can also be unsystematic and can vary due to cultural influences. Norris (2004) suggests that careful attention to the multiple possibilities of gaze configurations is necessary since it is difficult to ascertain what a participant is looking at. Analysts therefore must account for what actors perceive in an interaction by attending to the reaction of the other participants (Norris, 2004).

Layout. Layout refers to the environment (setting, objects, etc.) that structures the interaction between participants (Norris, 2004). Layout plays an important role in an interaction by providing topics for discussion and shaping the course of the interaction (e.g., natural boundaries of the objects/space determines who may speak to whom and at what point; de Saint-Georges, 2004). Workplace studies by Button (1993), Galegher and colleagues (1990), and Lynch & Woolgar (1990) have found that the physical arrangement of interactional settings and the artifacts used in the setting are important interactive resources. These studies assert that the interaction of artifacts, social configurations, and physical arrangements bring about changing patterns of participation in material and discursive practices. Studies by Roschelle (1992), Roth & Roychoudhury (1992), and Roth and colleagues (1999) have established how artifacts used in the setting affords coordination in learning settings. Roth and colleagues (1999) assert that the layout in part determines learners' differential participation and as a result influences who learns and to what extent.

Other modes. Aside from the previously mentioned modes, there are modes that can be embodied or disembodied (Norris, 2004). For example, modes such as music and print (e.g., written text and images) becomes an embodied mode when an actor uses mode or print to express perceptions, thoughts and feelings (e.g., a musician playing the ukulele, a person writing a list of grocery items). On the other hand, the mode is considered to be disembodied when an actor reacts to the music or print created by others (e.g., a person reading a list of grocery items). The boundary between embodied and disembodied are not always clear but when a mode is taken as an extension

of an actor's body (e.g., playing an instrument, writing, drawing, etc) then it is embodied. Norris (2004) asserts that since interactions are always co-constructed, modes are always embodied and disembodied in such that an actor's embodied mode can be utilized by the interactor as a disembodied mode.

Like gestures, disembodied modes such as material resources also follow a certain hierarchy due to the differences in affordances. For example, an image of a thermometer has a different affordance than an actual thermometer. The image may be more apt to use when a teacher is discussing the calibrations of a thermometer whereas an actual thermometer may be more useful for learners to explore how a thermometer actually works. Hence, in this example, material resources have the different possibilities of prompting, changing, sustaining, or closing a course of action.

5.6 Methods

5.6.1 Program and Participants

In Midwest City, Burmese Center hosts an afterschool program that provides resettled Burmese refugee youth with college preparation help and tutoring. Within this afterschool program, the authors facilitated Project RESET (Refugee Youth Engaging in Critical STEM Literacy and Learning), a weekly 90-minute STEM program which engaged Burmese high school sophomores and juniors in learning about weather, climate and climate change. In 2015-16, RESET met a total of 21 sessions doing various small group activities such as online research, readings, presentations, lab experiments, demonstrations, video making projects and whole class discussions on open-ended questions. On average, about 15 youth participants attended the sessions. Participants were ethnically Chin (one of the major ethnic groups in Myanmar), spoke multiple ethnic languages (e.g., Hakha, Falam, Burmese, Zophei, Matu, etc.), and had varying levels of English proficiency. Roughly half of the participants attended the high school where the sessions were held.

In our afterschool program, although most of the facilitators are multilingual, the non-Burmese facilitators were able to speak to learners only via English. Our learners on the other hand have varying degrees of fluency in English and in the multiple Chin ethnic languages they speak. Thus they were able to speak to one another, at least in varying degrees. Non-Chin facilitators had

to rely on our Chin learners and Chin facilitators to translate for us when we needed to directly convey information and to us when we needed to understand learners' discussion that were occurring in their multiple Chin languages. Although we acknowledge that speech is information dense, it is *conditionally* information dense only if interlocutors use a same named language . Even then, we still take cues from all the other modes. Hence, in our afterschool setting, spoken language alone did not have the information density required to be able to communicate *meaningfully*, highlighting the *necessity* for the use of all modes available. We all had to use an ensemble of modes to even try and make sense of one another. Thus, in the context of the multilingual setting of the afterschool, communication between learners and with facilitators is a complex multimodal process; wherein, "language alone cannot give...access to the meanings of the multimodally constituted messages" (Kress, 2003, p.35).

5.6.2 Data Collection and Processing

We collected ethnographic data by video-recording each session using two cameras situated at two corners of the room, screencasting participants' computer use using Open Broadcaster Software, imaging participant-generated artifacts (e.g., chart papers, worksheets), conducting interviews, and writing field notes.

For this study, we analyzed data from Session 3, focusing on four groups (1 dyad and 3 triads) out of the five that participated in this session. We did not include the one group located in a blind spot of our video-recordings. For Session 3, participants conducted online research to answer weather-related questions they had generated previously. Questions that focal groups tackled were: '*What is the difference between smog and fog?*' and '*What causes global warming?*'. The non-focal group addressed the question: '*How does pollution impact China compared to the United States?*'. We chose data from this session because we wanted to understand how learners participated in learning tasks within self-selected small groups. Moreover, data for this particular week involved the use of multiple modalities among learners with varying degrees of language proficiency in English and non-English languages.

Data analyzed for this study include 40-minute screencasts of each focal group's computer use and 90-minute session video-recording. Session 3 was organized into three activities: opening exercises, online research, and presentations (See **Figure 5.2**). We focus on Segment 2 (online research) since this is where the majority of learners' peer-to-peer interactions occurred.

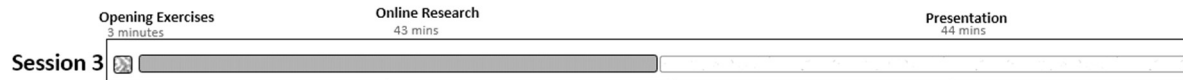


Figure 5.2. Organization of Session 3 according to Activities

We had multiple raw, unedited video files from the two camera angles and the screencast data. Author 1 synced the all three video files using Camtasia software and created what we will refer to from hereon as a processed video file. The audio-recording that gave the best sound quality was used as the soundtrack for the processed video file. This processed video file was used for data analysis. In addition, ethnographic information based on interview data of participants when available were used to situate the findings. Some of the focal participants in this study were interviewed for a published article on resettled refugee youths' narratives (Ryu & Tuvilla, 2018).

5.6.3 Data Analysis

Drawing on principles of video analysis (Derry, et al., 2010), we started the analysis free from predetermined analytic categories and viewed/listened to the processed video file repeatedly. In each iteration of data viewing, we watched the video portion only, watched the screencast portion only, listened to the audio-recording only, or viewed/listened to the processed video file which had all the synced portions altogether. This informed how Author 1 segmented the video file data into *video segments*. Video segments started with a trigger (e.g., instructions, a new micro-goal) that caused participants' actions (e.g. shifts in participant structure, spatial orientation) and ended with another trigger. In **Table 5.1**, we provide an example of a table of segments to give readers an idea of how a focal group conducted their online research. The table includes a column for the segment number and duration, name of the segment that highlighted the trigger or the learners' goal in the segment, and a short description of what transpired. We note that the trajectories varied for each focal group since interactions are unique.

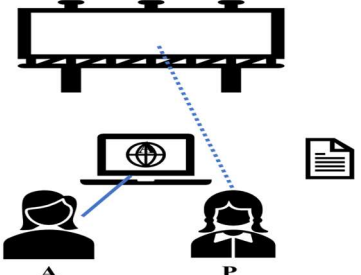
Table 5.1. Example Table of Segments

Segment Number & Duration	Name of the Segment	Description of the Segment
Segment 1 [0:22:18.4] – [0:25:24.4]	April and Phyu Choose a Topic	April and Phyu arrive and decide to work together. They choose a topic from the list on the board. They negotiated and re-negotiated their roles (e.g. whiteboard reader, computer person, writer) through their arrangement and re-arrangement of material artifacts.
Segment 2 [0:25:24.4] – [0:26:55.8]	April and Phyu research “What is Greenhouse Effect?”	The girls choose the topic “What causes global warming?”. They work on their question and shifted to researching “What is greenhouse effect?”.
Segment 3 [0:26:55.8] – [0:34:09.1]	April and Phyu conclude that “Greenhouse gases act like a blanket”	April did most of the writing while Phyu read. Phyu interacted with other groups and passersby while April kept writing. Phyu offered to contribute by writing instead of April. Phyu ended up grabbing the paper to write one of their references.
Segment 4 [0:34:09.1] – [0:38:54.9]	April and Phyu find “Greenhouse gases have different heat trapping abilities”	April and Phyu puzzled over how to fit what they are writing on the worksheet. The girls switch roles with April as the computer reader and Phyu the writer.
Segment 5 [0:38:54.9] – [0:44:37.4]	April is convinced their task is done “I think we hit the nail!”	Phyu asks for clarifications on what was being written in the worksheet when previously she seemed less involved. Phyu evaluated what April read to her. Phyu shows her dissent by not writing. They negotiate who will “do the talking” to present their findings.
Segment 6 [0:44:37.4] – [0:47:21.5]	Phyu asks “What if they ask ‘How does animal behavior change?’”	Phyu framed the question “How does animal behavior change” as a question that other participants could potentially ask. April initially did not engage with the topic and Phyu decided to research it anyway.
Segment 7 [0:47:21.5] – [0:56:45.9]	April and Phyu explain their research findings to MJR	The girls enthusiastically engaged with MJR. MJR asks a question that Phyu started to answer. April interrupted and grabbed the worksheet with their answers from Phyu.

Then, *events* were selected from each segment that were pivotal in the interaction (e.g., learners making decisions, discussing next steps to achieve their learning goal, etc.). Clipping video file data into discrete analytical unit of *events*, “smaller units of coherent interaction” (Jordan & Henderson, 1995, p. 20), ensured that contexts that led to participants’ action and immediate

outcomes were captured within an event. In a particular segment, the number of events varied, ranging from zero to as many as seven. On average, events in a particular session were about 2-10 minutes long. Author 1 generated event transcripts to capture utterances, gesture, body posture, gaze, computer use, organization of artifacts and use of space (Knoblauch & Schnettler, 2012; Flewitt, Hampel, Hauck, & Lancaster, 2014) of focal groups and other actors who interacted with focal group members (e.g. facilitators, non-focal participants). The first phase of transcription captured the utterances. Although majority of the conversations were in English, some exchanges (about 2-5 turns) were spoken in Hakha or Falam and we had a translator from the same community translate these exchanges into English. When needed, Author 1 sat with the translator to ask questions on possible interpretations of interactions. In other instances, translators left transcription notes on the transcript to further contextualize the interactions. The second phase of transcription parsed out the nonlinguistic modes when salient in the interaction. Author 1 analyzed proxemics, placement of material artifacts, gestures, and body postures by focusing on the video recordings. Gaze was analyzed when possible – as this was dependent on the quality of the video recording. Author 1 used screencast data to track learners' cursor moves, observe what images and texts learners might be seeing in their computers, and record what search terms they used. The nonlinguistic modes were captured by writing them down in a table. These layers of transcripts that included English translation were then reassembled to create a multimodal transcript. We share an example of a multimodal transcript in **Table 5.2**.

Table 5.2. Example Excerpt of a Multimodal Transcript

Time Stamp and Linguistic Transcript	Non-Linguistic Transcript and Interaction Maps	Interpretation
<p>(0:34:17.8)</p> <p>April: Okay. <u>Different greenhouse</u> <u>gases have very</u> <u>different</u> uhm (.) okay</p>	<p>A is reading from the screen with her face close to it and her body angled towards the laptop.</p> <p>P glances at what A is reading.</p> <p>P's gaze turns to the board yet her body is upright. P appears to be in a daze as she pulls a few strands of her hair.</p> 	<p>A seems very intent. Her initial “okay” just like in previous moments seem to indicate this is her next action. Her utterance of the final “okay” seem to indicate that she is ready to proceed to the next task – that is writing what she has made sense of.</p> <p>P seems distracted as suggested by her dazed look.</p>

The three-column multimodal transcript used time as an anchor and included both the linguistic and non-linguistic layers of the transcript, and interpretations. In certain instances, we created interaction maps. Interaction maps (shown in “Findings”) were generated to represent changes in spatial positioning of artifacts (e.g., computer, paper) and/or actors. Icons of artifacts (e.g. board, computer, paper) as well as people with the learner’s initials were used to symbolize who and what were involved in a moment. Solid lines represented sustained interactions (e.g., speaking to another actor, manipulating artifacts) while broken lines represented transient interactions (e.g., touching artifacts, gaze). Arrowheads indicate directionality of the interaction and could be one-directional or bi-directional.

We proposed multiple interpretations of learners’ actions and how it structured the succeeding actions/reactions. From learners’ actions manifested through their use of modes of speech, proxemics, gaze, gesture, posture, etc.; we examined how the learners coordinated the various modes in their negotiations of their participation. We sought to understand how learners utilized each mode individually and in coordination with other modes in their interactions with

other learners, facilitators, and the artifacts and layout of the setting. We examined how their coordination of modes played in the negotiation of the various identity elements of their membership, roles, and cognitive authority. By negotiation of participation, we looked for instances when learners acted and reacted over differential access to resources; attributed statuses and accepted/rejected statuses to one another; and agreed/disagreed over differing points of view which eventually resulted to consensus or further negotiations. We also took into account the contexts of the tasks, the learners' micro-goals, and the developing norms of the groups. We validated our assertions on the microanalysis of the interactions and ethnographic information gleaned from other data sources (e.g. field notes, interviews) and constantly revisited earlier interpretations (Jordan & Henderson, 1995). Analytic notes of the microanalysis of each event were then written. Categories (e.g. coordination of artifacts and space to negotiate group membership) were generated through constant comparison (Lincoln & Guba, 1985) between events within a group or between groups

In sharing our findings, we created presentation transcripts that contained stills we took from the video recordings or the screencast data of focal groups' computer use that were salient in demonstrating learners' use of non-linguistic modes. The presentation transcripts were necessary since the multimodal transcripts would take up multiple pages for a few seconds of interaction. Utterances in the presentation transcripts included the utterances learners spoke in English as well as the English translations of utterances spoken in their Chin ethnic languages. We differentiated between the English utterances and the English translations by writing the turns in different font styles. The different font styles also nuanced between the various Chin ethnic languages. In **Table 5.3** we include a transcription key to guide readers in interpreting the presentation transcripts.

Table 5.3. Transcription Key

Symbol	Name	Use
¹	Bolded numbers (superscript) located before bolded letters	Turn number
ABC	Bolded letters followed preceded by Turn number and followed by colon (:)	Initials of Speaker
((Text))	Double parentheses	Annotation of action or description
<u>Text</u>	Underlined text	Denotes text read from a source (e.g., computer, book, etc.)
<i>Text</i>	Text in Italics	English translation of utterance originally in Hakha
(.)		Denotes a pause; number of seconds indicate longer pause
(hhh)		Audible inhalation/exhalation
***	Asterisk (s)	Unclear speech
:::	Colon (s)	Indicates prolongation of an utterance
ALL CAPS	Capitalized Text	Indicates shouted or increased volume speech

Unless indicated as abridged, the transcripts included all of learners' utterances. We created abridged transcripts for brevity and clarity wherein we wrote narrative descriptions of what transpired. Though our multimodal transcript broke down learners' actions into their parts, in the abridged transcripts we captured learners' higher-level action. Higher-level actions are the actions from a chain of lower-level actions built by each mode utilized (Norris, 2004). For example, presenting a poster in front of the whole group as a higher-level action uses the multiple modes of using utterances, gestures, body posture, gaze, use of artifacts, etc.

5.7 Focal Groups

Before we present our findings, we provide ethnographic information on the focal groups to situate later descriptions of their negotiations. We have interviewed several of the focal participants but not all of them. Thus, the richness of the ethnographic detail varies across the participants.

5.7.1 Triad 1: Betty, Mala, and Sanda.

Betty moved from Burma to Midwest City at age 14 without passing through a third country. She had lived in Midwest City for three years when we met her. She started school in the US in the 7th grade. She recalled that it was hard because she did not know English and she had no friends. Betty speaks Falam, Mizou, and Burmese. She perceived herself as being unable to do science because “[she] is not smart” and she always gets Ds and Cs in her science classes. During Chin National Day (a cultural celebration), Betty showed us around and introduced us to different Chin cuisine and patiently explained the symbolic meanings of the dances and the traditional clothing. We were able to meet some of her teachers and we had the impression that she was well liked.

Mala and Sanda are twins who know Betty from school. They also speak Falam. They lived in India before resettling in the US. We were not able to interview them so we have very little information about their migration history. When we met them, they have been in the US a little over a year. Mala was the more active twin. She would volunteer to read in front of the group and independently worked on a few activities. She also jumped in to answer questions when prompted. On the other hand, Sanda was shy and often hesitated to participate especially when Mala was not around.

Owing to their perceived lack of English proficiency, the three girls rarely spoke in whole group discussions. It took some coaxing to get them to speak in front of the entire group.

5.7.2 Triad 2: Tom, Paul, and Moe

Tom was around 11 years old when he left Burma to live in Malaysia. He described living in Malaysia as fun but “sometimes [he was] afraid of getting caught by the [Malaysian] police”. He attended a school offered by the refugee organization that was assisting his family. He got lessons on the Burmese language, math, art, and English. His father died while they were in Malaysia. He eventually resettled in the US with his mother and two sisters. When we met him, he had lived in Midwest City for five years. In school, he loved history and math but he disliked the sciences with the exception of physics (because of his fascination with how the US used the atomic bomb in World War II). He pointed out that one of the challenges of being a Burmese student is the inability to speak English well. However, he also pointed out that though “[his]

grammar is never good...[he] doesn't care about grammar, but he cares more about [his ideas]". Tom speaks fluent Hakha and Zophei.

Paul left Burma when he was 8 years old. His family endured "harsh travel" conditions in crossing the border to first get to Malaysia where they lived for one year. His family moved to Midwest City where he started attending school in the fourth grade. He was in an ESL class for two years where he had a great teacher. Children's cartoons also helped him learn English. Having lived in the US for 8 years when we met him, he is most comfortable speaking English out of all the languages he speaks. At home, his mother encouraged him and his brother to speak in English so she could learn as well. However, since Paul's father does not speak English, Paul communicates with him in Zophei. Paul learned Hakha from interacting with other Chin peers. He is one of the few participants in Project X who shared that he is "fairly comfortable in the school environment".

We did not get to interview Moe so we do not have a lot of information about his background. We do know that the three boys are close friends. They always worked together in the program. They always had inside jokes and laughed a lot. Moe spoke to Tom and Paul in Hakha as he does not know Zophei. Tom and Paul were very outspoken and their ideas were listened to and taken up by the RESET participants.

5.7.3 Triad 3: Valerie, Jin, and Dan

Valerie described her life as a refugee as having been "easy". She left Burma at age 9 and moved to Malaysia having access to the resources provided by her father who had relocated there much earlier. Thus, she was spared from hardships typical Burmese refugees encountered as her family had the protection of the United Nations. While in Malaysia, she attended classes that taught her "American ways and their basic manners". Her family resettled in the United States in a "nice area" in New York. She credits "having learned English very fast" to living in an area where there were not a lot of Chins to talk to and thus she was forced to communicate with her classmates from diverse backgrounds in English. She also "tried really hard to communicate with people...[using] gestures a lot...and wasn't shy about speaking even if [her] sentences were awkward". Valerie states that her favorite subject is English and among the sciences she likes biology but dislikes chemistry and physics. When Valerie participated in RESET, she had been in the US for 6 years.

She is regarded as a youth leader by her peers as she takes up leadership and organizing roles in the non-profit organization that hosts the program. She is outspoken and assertive of her ideas.

Unlike Valerie, Jin and Dan had experienced the “illegality” of being a (Refugees International, 2005) . Jin’s dad faced the threat of imprisonment and fled for Malaysia to seek help from the UNHCR. Jin was around 9 or 10 years old when he left Burma and was finally reunited with his father. Jin spent two years in Malaysia before first resettling in Washington State in the US. When we met Jin, he had lived in Midwest City for 6 years. Meanwhile, Dan, who is Jin’s cousin and best friend, had lived in Midwest City for 5 years. Though both boys were no longer taking ESL classes when they participated in RESET, they still perceived themselves as not proficient in English. For example, their discomfort with using the English language in school is palpable. Though comfortable with speaking English around his friends, Jin “doesn’t want to make too many mistakes in front of teachers”. Dan describes his English language proficiency as “simple...[using] very simple and common words [that] it won’t make sense.” When asked about their schooling experience, Jin felt that “since there’s only few [ELs] in class, the teachers don’t go easy...It’s pretty common that some people like [them] are left out sometimes.” Dan adds that “if [his classmates] are not kind they just [proceed with the discussion] and be selfish”. Both boys expressed a desire to pursue engineering degrees with Jin wishing to work for NASA although he says it is “impossible” and “only a child’s dream”. Meanwhile Dan, wants to build buildings in Burma¹⁷.

Jin and Dan worked with each other in most sessions. They tend to sit in the back of the room and contribute to the discussion only when asked explicitly. For this particular week, they worked with Valerie since they already know her and they all spoke Hakha.

5.7.4 Dyad: April and Phyu

April’s migration history is similar to her cousins Jin and Dan. She went to Malaysia earlier than Jin and Dan when the refugee network was still being established. She has lived for 8 years in Midwest City. She was no longer taking ESL classes when we met her but perceives that “there’s

¹⁷ As of our last interaction with them, both boys are going to business school instead. They got accepted to engineering programs in the satellite campus of their first choice university but declined the offer because their scholarship would only cover their tuitions but not their living expenses.

so much English words that [they] don't know". When April has difficulties in school, she asks her teachers, friends, and even her younger sister "because she started in kindergarten, so she knows the basics". She uses both Hakha and English comfortably and even laughingly recalls that there have been moments when she would speak to her friends and teachers in Hakha unknowingly. April has expressed a desire to become an archaeologist but thinks that it would be more practical for her to either be a nurse or a midwife.

April and Phyu are cousins, the best of friends, and classmates. They usually work together in RESET. Both speak the same home language Hakha and speak English fluently. We were not able to interview Phyu and do not have information about her migration history. Based on our observations of their many interactions in RESET April is the more outspoken of the two. April does not hesitate in sharing her ideas and asks a lot of questions in the program.

5.8 Findings and Discussion

We organize our findings by negotiation themes and how the multiple modes inform learners' negotiations. In each subsection, we share several key examples from the different focal groups. We provide presentation transcripts with stills of the video-recording of focal actors/groups and/or stills from the screencast to showcase the multiplicity of modes the learners used when salient to the interaction. We then provide our interpretation of the interactions and how each mode functioned in the learners' negotiations. We end each subsection with a summary that spans across the examples from the multiple groups.

5.8.1 Negotiating Group Membership

In this subsection we share examples that demonstrate how the learners negotiated group membership multimodally. In our analysis, we looked at the goal of the interaction which could either be a task interaction or a relationship interaction. *Task interactions* are group actions geared toward accomplishing the group's task or goal; while *relationship interactions* are group actions that sustain, strengthen or weaken interpersonal relationships in the group (Bales, 1950, 1999). *Structure* refers to the organized and predictable patterns that emerge in a group that determine what actions are allowed or disallowed (e.g., who talks to whom, who likes/dislikes whom, who is expected to perform certain tasks, and who others position to lead/follow) (Forsyth, 2014).

Cohesiveness refers to the solidarity or how the group acts as a unit (Forsyth, 2014). We hold that these characteristics are intertwined and indicative of group membership.

We share still images that are representative of how the focal participants positioned themselves and arranged the material artifacts and the space surrounding them. We chose these images as they denote how learners configured themselves over the course of the 43-minute online research activity. We annotate the still images as follows: solid double headed arrows denote the distance between participants (proximity), the dotted single-headed arrows denote how the participant align their bodies (body positioning) and gaze, while the circles focus on the arrangement of the material artifacts (e.g., laptop computers, worksheet, pen, etc.).

Triad 1: Betty, Mala, and Sanda – Disjointed Membership



Figure 5.3. Betty, Mala, and Sanda

In the first triad (**Figure 5.3**), Betty is seated much farther away from Mala and Sanda. There is an obvious divide between Betty and the twins. Both sides have laptops and the twins have the worksheet on their side. Betty's gaze and body position is directed to the opposite direction of the twins. Meanwhile, the twins' gazes and body positions are coordinated with one another, which is a marker of collaboration (Kendon, 1990). An implication of this arrangement is that Betty's interactions with the group is limited compared to that of the interactions between Mala and Sanda. This results into Betty's disjointed membership in the triad, stilted the development

of interdependence within the group towards accomplishing task goals, and affects the cohesion among group members.

In this particular activity where learners are actively doing online research to answer a science question, learners' science identities influence the negotiations of learners' participation in the task. Betty's more distant seating and limited interaction with her group members appear to be shaped by Betty's perceptions of her science status relative to her peers. Betty (B) perceived herself as being of lower status compared to her peers. Unprompted, Betty turns to MT, the first author, and exclaims that "Science is so hard". Betty insists that she does not have ideas, "[she]can't think", and that she always gets Ds and Cs in science. She compares herself with her peers as demonstrated by this excerpt from the exchange:

Transcript 5.1 "I'm not smart"

- | |
|--|
| <p>¹ B: Seriously I cannot. I think this is not my subject.</p> <p>² MT: You think what is not your subject? Science is not your subject? ((B nods)) Why do you think that? So you think other people, it is their subject?</p> <p>³ B: Yeah, they are really good at science ((Makes a sweeping motion with her hands))</p> <p>⁴ MT: What makes you, what do you think makes them good at science. So you think you're bad at science?</p> <p>⁵ B: I'm not smart.</p> |
|--|

Triad 2: Tom, Paul, and Moe – Symmetric Interdependence

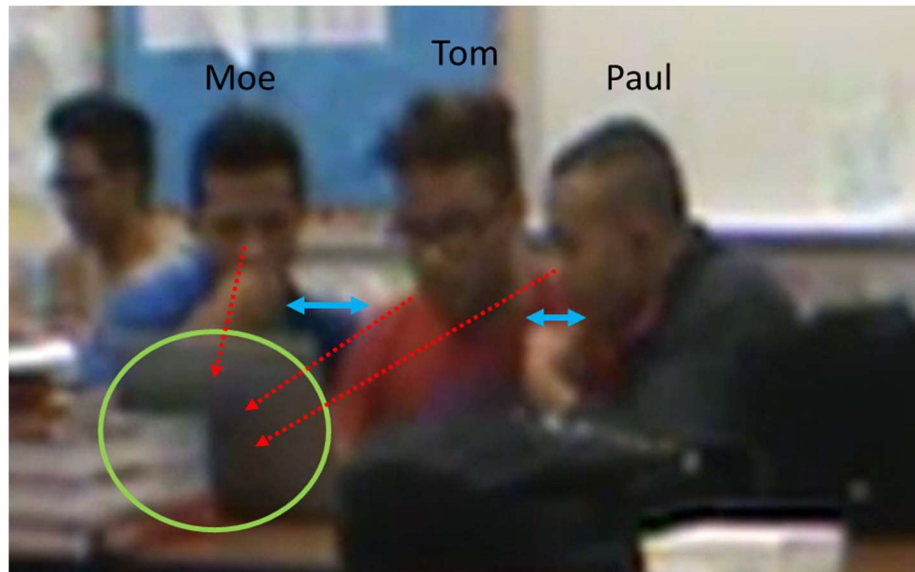


Figure 5.4. Moe, Tom, and Paul

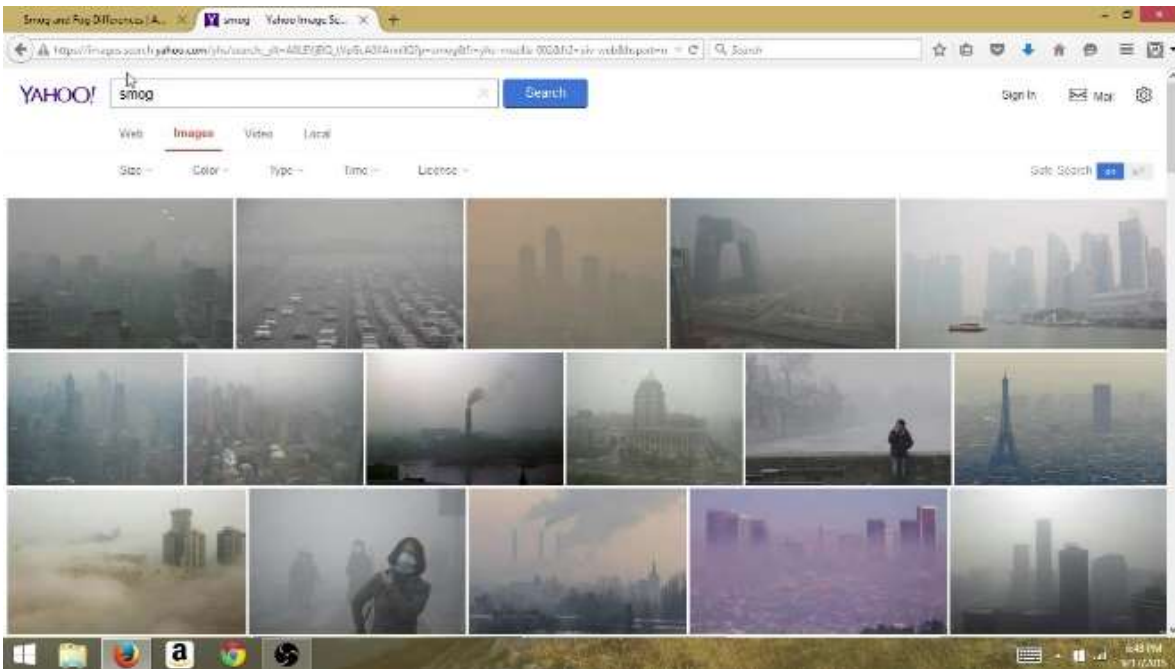
In the second triad (**Figure 5.4**), Tom (T), Paul (P), and Moe (M) are seated close to one another. Although, Moe has his own laptop while Paul and Tom share one, in this moment (which was sustained for the most part of the interaction) the three boys all align their body positions and gazes towards the same laptop computer. This suggests synchronization of their moments and indicative of their collaboration (Kendon, 1990). Due to their close proximity, they are freely able to interact with one another which strengthens their identification as group members, fosters interdependence towards their mutual goal, and encourages group cohesion. They perceive themselves as equal-status members. Moe who does not speak Zophei (the language that Tom and Paul both speak) is able to ask questions and expect answers from his group members as evidenced by this exchange.

Transcript 5.2 Smog vs. Fog

¹ **M:** Can we, can we look at the pictures? I still don't get it. I'm still kind of confused. I mean smoke and then fog. Smog and fog how is it different?

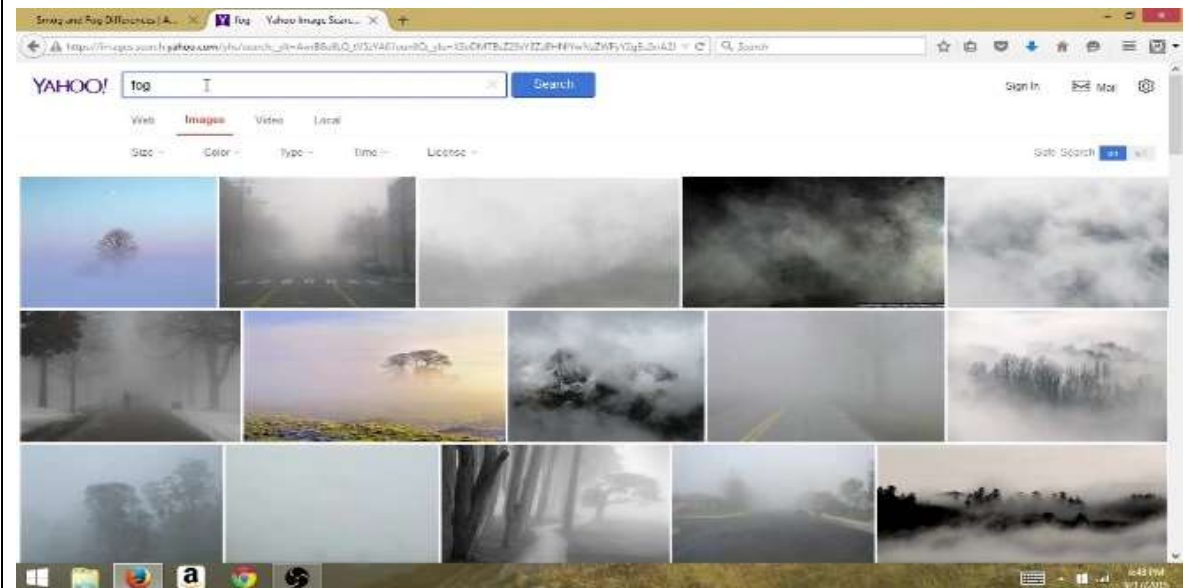
((On the screen, "Smog" is typed))

² **P:** Smog is the. Smog is poison cloud.



³ **T:** *Show the fog again*

⁴ **M:** Ah, okay. Smog is like by cars right but this, this is natural. It's by water.

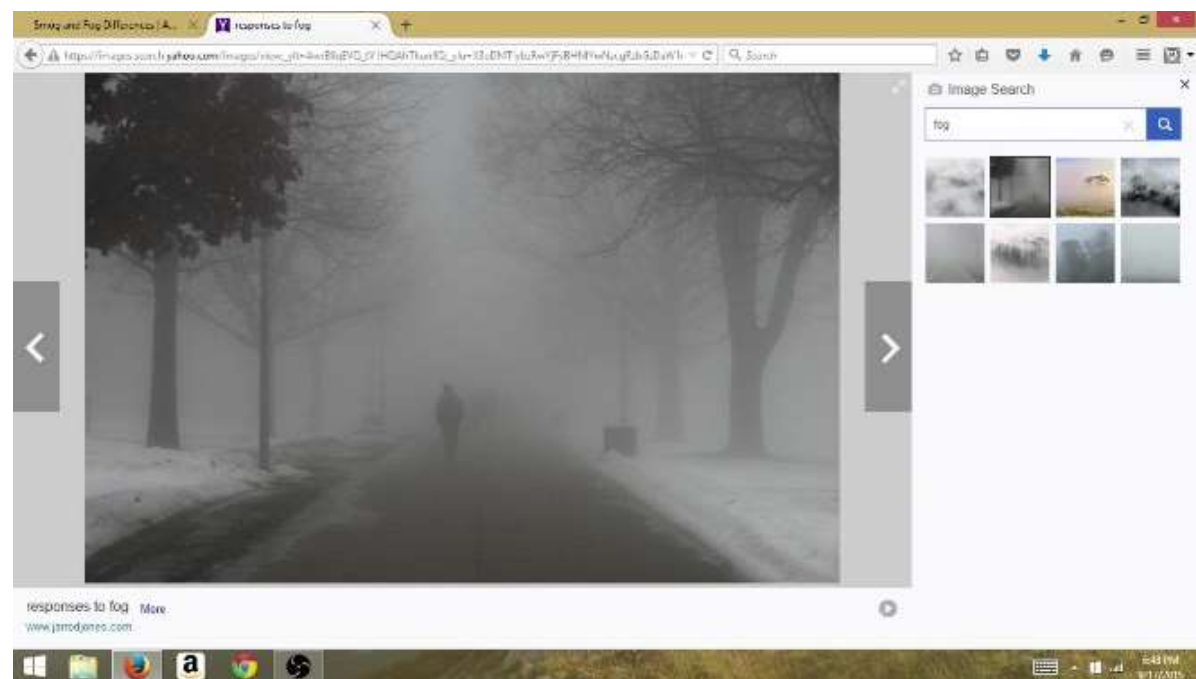


Transcript 5.2 continued

⁵ **T:** See, this is beautiful

⁶ **P:** Like clear

⁷ **T:** No, it is not actually water. It contains water but not actual water.



⁸ **T:** It is a cloud on the ground. ((Laughters))

⁹ **M:** Cloud in the ground. Cloud in the ground ((Playful, said in a deep voice))

¹⁰ **T:** That's how they define it.

¹¹ **P:** Cloud where are you? ((Salutes with his right hand. Gestures as if looking for the cloud))

¹² **T:** Cloud contain water,

¹³ **M:** Okay, cloud in the ground.

Triad 3: Valerie, Jin, and Dan – Hierarchical Collaboration

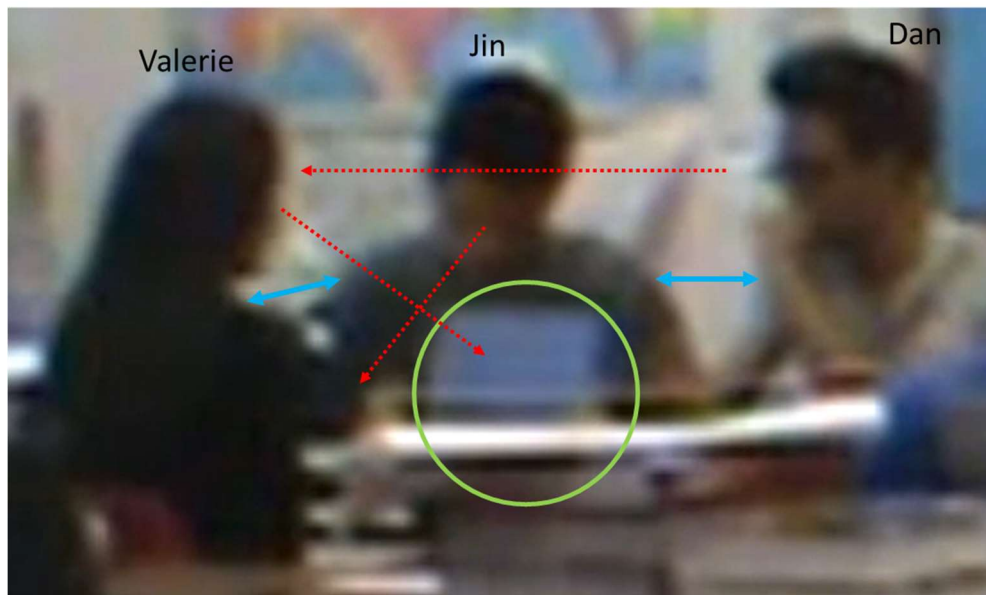


Figure 5.5. Valerie, Jin, and Dan

The third triad (**Figure 5.5**) consists of: 1) Valerie (V) solely facing the laptop computer, her gaze alternating towards the computer and her group members; 2) Jin (J) who has sole possession of the paper and pen, his gaze alternating between the writing implements and Valerie; and 3) Dan (D) whose body posture and gaze are directed towards Valerie and Jin. This arrangement came to be when Jin hands the laptop computer to Valerie and she accepts it and states “I like searching”. Valerie accepts the role attributed to her and takes ownership of the use of the computer. When Dan inquires about the writing, Valerie offers that “[her] handwriting is so big it won’t fit [the paper]”. We pose that Valerie readily accepted the laptop as this is befitting her preference of liking to do the research but her implicit refusal and offer of an excuse not to do the writing can be interpreted as her way of ensuring she does not do both online research and write the answers as well. This inevitably prevents her group members to engage in social loafing where her group members exert less effort to accomplish the task while she does all the work. We argue that this positioning is based off the triad’s previous interactions wherein Valerie is constantly positioned as a leader and Valerie’s high status among her peers. This asymmetric arrangement shows the typical unequal and hierarchical interdependency that develops in a triad (Forsyth, 2014). This positioning is further cemented as shown by this excerpt of their exchange:

Transcript 5.3 British affectation

¹**D**: So-
²**J**: So what is- ((Head bowed towards pen and paper as J starts to write))
³**V**: So okay-
⁴**D**: So what's' the
⁵**V**: That's not where - ((Start of a British affectation)) - you write the answer. The answer should be here. Can you not see? Are you blind? ((End of British affectations))
⁶**J**: His eye is blind ((D laughs)) Oh, oh, you ((Directed to V)) even put a bullet point on it already
⁷**V**: ((Laughs)) Okay, Okay, write this down. ((Start of British affectation)) Global warming ((End of British affectation))
⁸**J**: G-L-O
⁹**V**: Semi colon
¹⁰**J**: Global.
¹¹**V**: ((Start of British affectation)) Global Warming with an M-I-N-G ((J laughs)) Oh my god, do you not know how to spell ((End of British affectation))
¹²**J**: I wasn't thinking.
¹³**V**: Okay ((Laughing)) Semicolon
¹⁴**J**: And then
¹⁵**V**: An increase (6s) in (2s) earth's (3s) overall (5s) atmosphere

We pose that Valerie's British affectations are meant to be humorous as evidenced by the timing of *when* she switches to her British affectation (**Turns 5, 11**) to couch her emerging role as the director of the task. Jin and Dan play into Valerie's attempt at humor and acceptance of Valerie's director role as shown by their laughter (**Turn 6**) and self-deprecating utterances such as Jin's statement (**Turns 6, 12**).

Summary

Beyond inferring the internal dynamics of the group, we can also make specific observations regarding the different groups. For example, although in Triad 1 and Triad 3 members have not synchronized their movements, the groups differ in terms of the level of collaboration and or membership. Betty and the twins might as well be two different groups in how they arranged themselves. Whereas, Valerie's group does act as a single unit despite specializing in tasks. Comparing Triad 2 against the two other triads, we can tell that the three boys collaborate and contribute equally to the task. In Valerie's group, by virtue of having the computer on her side, Valerie appears to direct the rest of the tasks.

5.8.2 Negotiating Roles

In the subsection that follows, we share examples on how learners negotiated emergent roles in the moment of interaction. By emergent roles we refer to roles that come up from the learners' dynamic micro-goals established moment to moment in the process of accomplishing the group goal. We recognize that the group goal of researching a climate-related question is constituted by multiple subtasks that could include deciding a research question to investigate, researching, making sense of information, deciding on how to present their findings, deciding which information to include in their presentation, among many others. In our analysis, we paid close attention to the roles that are salient in the specific moment of analysis.

Triad 1: Betty, Mala, and Sanda

We revisit Betty, Mala, and Sanda and share the following abridged multimodal transcript (**Transcript 5.4**). In the exchange, the three girls have already formed group and are in the initial stages of starting their research task. They implicitly negotiate the roles they will play in the research task. The roles that emerged in this task were that of: computer user, writer, board reader, and computer reader. Sanda by default becomes the *computer user* as it is her personal computer that they are using for the activity (1). Mala takes out her pen and becomes the *writer* making Betty the *board reader* (2).

Transcript 5.4: Push-pull over pen and paper

1: Seated from left to right: Betty, Mala, and Sanda. Mala has the worksheet and pen. Sanda has the computer.



2 Betty reads from the board to Mala. “What is smog?” as Mala writes on the worksheet.



3 Betty attempts to take the pencil away from Mala but instead removes the cap. They laugh about it



4 Betty writes/erases items on the worksheet as Mala looks on. Sanda is on the laptop.



Transcript 5.4 continued

- 5 Mala attempts to take the paper away and Betty moves it out of Mala's reach.



- 6 Mala manages to take away the pencil and paper. Left with nothing to do, Betty plays with her face.



- 7 Betty looks over the twins' shoulder. Sanda reads from the laptop as Mala writes on the worksheet.



8 Betty works separately from the twins.



Betty attempts to renegotiate her *board reader* role by trying to take away the writing implements from Mala. They engage in a playful back-and-forth of trying to take the writing implements from one another (3-5). Though this was playfully done there are implications on this exchange – one being that the *writer* role is more appealing than the *board reader* role to both Mala and Betty. We posit that the *board reader role* is only important in the beginning of the task while the group is trying to figure out the topic of their inquiry. Once that is done, there is not much to do and thus, is the least preferred role. In addition, the *writer role* creates permanence of the writing contribution wherein the writing remains (or becomes a disembodied mode) even after the act of writing; whereas sound, which is the medium for reading is transient and the contribution does not translate into the worksheet, where the final product is displayed. Mala finally manages to take away the writing implements and turns to Sanda to write on the worksheet (6). By virtue of her location, Mala gains access to the computer and becomes both *computer user* and *writer* as Sanda becomes the *computer reader* (7). In addition, we pose that Sanda's use of the computer either as *computer user* or *computer reader* is uncontested because she has ownership of the computer. Moreover, it is apparent that being a *computer reader* is a more preferred role than the *board reader*. We argue that this is the case since there was no attempt to renegotiate roles between Mala and Sanda. We hold that this is probably due to the value learners place on material artifacts wherein a computer holds more value compared to other implements due to the access to knowledge it affords. Also, the computer is an expensive, “fancy” (April), and high tech artifact that most teens wanted to interact with it. In a sense, the computer becomes another interacting

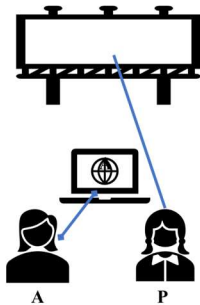
member of the group, which is sometimes given a lot of authority because of the computer's ability to shape the discussions (by suggesting keywords) and persuade group members (by providing evidences through texts, images, and access to knowledge) (Kelly, Crawford & Green, 2001). Due to the high value placed on the computer, an implied role that Sanda plays by being a *computer reader* is that of a *knowledge co-constructor* alongside Mala who has the writing power on what to put as final display on the worksheet. Due to Betty's perceived lack of a meaningful role to play – as she has no access to the computer by virtue of her location and her unsuccessful attempt to renegotiate her role -she decides to work on her own (8). This disintegration of the triad appears to be an untoward result of the lack of cohesiveness (Forsyth, 2014).

Dyad: April and Phyu

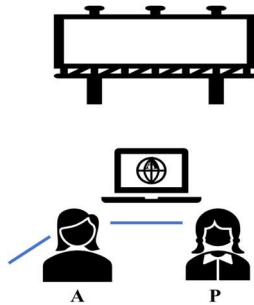
Similar to Betty, Mala and Sanda, the dyad of April and Phyu engaged in a negotiation of roles through proxemics and arrangement of artifacts. In the exchange, April and Phyu are deciding on the question they will tackle for their research task. MJR, a facilitator, hand them a laptop computer and both girls put their hands out to receive it. However, the computer was situated closer to April and by default April takes on the initial role of the computer user. Here, we present an abridged transcript (**Transcript 5.5**) of their interaction through interaction maps for clarity (since the still images of April and Phyu is partially obstructed by another group).

Transcript 5.5: Subtle Exchange of Roles

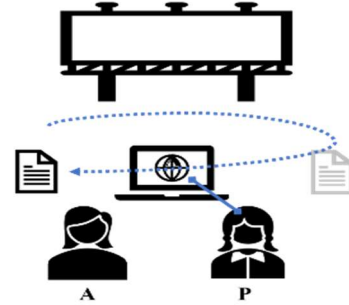
1: Phyu reads off the board, “What is global warming?” as April starts typing on the computer.



2: April looks to her side to take out a notebook from her bag as Phyu looks over her shoulder.

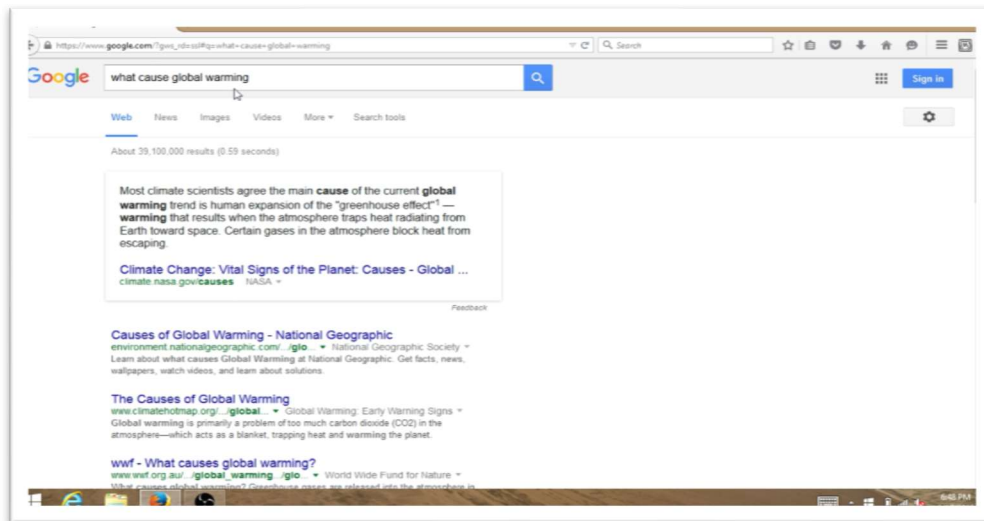
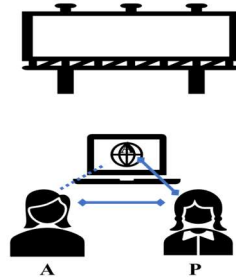


3 : Phyu slightly moves the laptop towards herself and tinkers with it. April takes out paper from the notebook and places it on Phyu’s side. Phyu places it back on April’s side

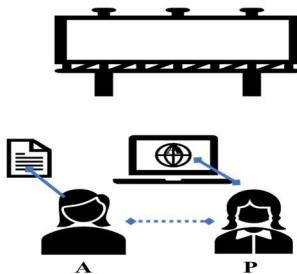


Transcript 5.5 continued

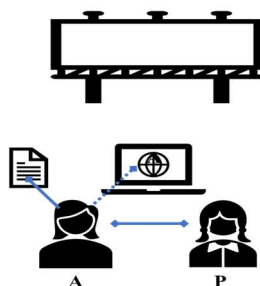
4: Phyu confers with April as she types in “What causes global warming?” on the computer. April’s gaze is towards the computer. Screencast image is shown.



5 : April writes down what she reads off the computer. Phyu dictates to April, “Our source of [inaudible] is National Geographic”



6 : Phyu continues to read from the laptop as April writes on the paper.



The negotiation of roles (e.g. board reader, writer, computer user) is influenced by the material resources available (paper and pen, computer) and April and Phyu's interactions with them. Initially, April assumes the role of the computer user because although both reached for the laptop together, April had a better grip on the laptop and pulled it towards herself. April places the laptop in between her and Phyu, but slightly more towards herself than Phyu. Phyu, though unprompted, immediately assumes the role of the *board reader* as she starts reading the question choices on the board to discuss with April the topic of their research (1). April provides the paper and pen and placed it on Phyu's side (2-3). This is April's way of communicating to Phyu that Phyu should write. However, Phyu placed it back to April's side and moved the laptop towards herself (Figure 5.16). Through this gesture and rearrangement of the artifacts, Phyu renegotiates her role. Thus, Phyu became the *computer user* and April the *writer*.

Summary

The examples of Triad 1 and Dyad reveal that negotiation of roles is accomplished through the rearrangement of material artifacts. We posit that learners attribute value to material artifacts depending on how they perceive the artifacts to help them accomplish their goals. Hence, material artifacts also have a status wherein the artifacts given higher status are those that provide learners access to information or help learners' contributions gain visibility/permanence. For this particular activity, in the hierarchy of material artifacts used the computer has the highest status since it gives learners access to information and equip them to make a knowledge contribution. Also, since the computer is designed for individual use, the limited access elevates its value. The paper and pen

have the next highest status after the computer as it allows learners to make contributions permanent in the expected output (in this case, the filled-out worksheet). The worksheet due to the texts that structures the activity gives it a high value. It is of course useless without a pen despite the pen being a readily accessible material and thus the pen holds the next position. Finally, the board has the lowest status due it being easily accessible to everyone and the only meaningful contribution using it stems from reading the texts on the board at the beginning of the task in this particular case.

The hierarchy assigned to material artifacts stems from group members' preferences over the roles they seek to play. The value attributed to the roles is based on productivity – that is, which role allows learners to make the greatest contribution towards achieving the goal (Engle & Conant, 2002). From both Triad 1 and Dyad, we can infer that in terms of the roles required to accomplish the research task, the *computer user* role is the most preferred role, followed by the *writer* role, and lastly the *reader* role.

The kind of contributions learners are expected to make or the roles they are expected to fulfill are influenced by status. In Triad 1, since Sanda was the unquestioned *computer user* due to her having ownership of the computer, there was competition for the *writer* role between Betty and Mala. In the Dyad, both April and Phyu wanted to be first and foremost the *computer user* and thus the renegotiation occurred. In the examples in the earlier section, Triad 3 (Valerie, Jin and Dan) immediately assigned the *computer user* role to Valerie possibly due to Valerie's high status. Positioned as the leader, she readily took on the role of directing the task as well. In Triad 2 (Tom, Paul, and Moe), there was no clear delineation of who fulfills which role as the members were of equal status and thus fluidly exchanged roles moment-by-moment. An implication of this is the that learners positioned with higher status have more access to material artifacts. The corollary is also true: access to material artifacts are granted or taken by learners who are positioned as having higher status.

5.8.3 Negotiation of Cognitive Authority

The examples we include in this section demonstrates how learners negotiated cognitive authority either through gestures, use of material artifacts, and use of images.

Use of Gestures (Action and Inaction) and Material Artifacts

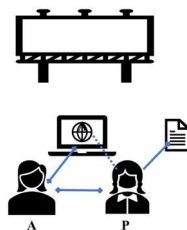
Dyad: April and Phyu

In the example we present here, Phyu negotiates for cognitive authority through her actions. April and Phyu are in the middle of researching “What is global warming?”. Previously, April served as the writer. April hands the worksheet to Phyu and asks her to write. This renegotiation of role results in April and Phyu switching roles wherein Phyu writes and April reads off the computer. We now present a transcript of the exchange.

Transcript 5.6: “None of it is important”

A reads a passage from the computer indicating to P what she should write. A would at times switch her gaze from the computer to P’s writing. P gazes at the computer from time to time as she writes.

¹A: ...oils (.) and natural gases(.) for energy (.) or cut down and burn forests (.) to create (.) pastures and plantations



²P: Where?

((P gazes at the screen. A points out the sentence she is reading to P.))

³A: Ahm, overload our atmospheres

⁴P: *We should just explain it* ((Translator Note: P is insisting to explain rather than write verbatim))

⁵A: Look how different my handwriting and your handwriting is

⁶P: *I have a soft heart* ((Translator Note: P is implying P is nice and forgiving.; [This is in reference to P offering to write in an earlier event because P was trying to be “considerate” since A had done much of the earlier writing.]))

⁷A: *But you’re lazy* ((Translator Note: A and P know each other well))

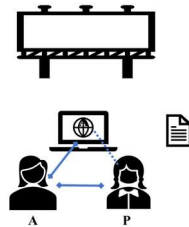
⁸P: No, because *it’s not showing well*

⁹A: Consequences. Over the – *I’m going to read first, don’t write it yet*

¹⁰P: It doesn’t matter. It doesn’t say what causes

Transcript 5.6 continued

P stops writing and forcefully places the pen on top of the paper. The pen makes a sound on impact.



¹¹**A:** *You are writing it. Whatever you pick up just write it casually like a note or bullet style.*
Over the century, global average temperature has increased more than 1 atmosphere or 0.7 Celsius. In 2001 to 2010 they came in the warm, warmest

¹²**P:** None of it is important

¹³**A:** No, it will have, just - warmest since of 1880, the earliest year for our com
(.)pre(.)hensive global temperature on record was available. In fact-

((**A** puts her face closer towards the screen, effectively blocking the text from **P**'s view. **P** shifts her posture and head position so to see the screen clearer))

-nine of the warmest years was on the record in the last 10 years. This warming has been contained by decreasing in very cold days and nights and increase in extreme hot days and warm nights. The contin- I mean - the continental United States for example has record daily

((**P** puts her head closer to the screen))

high twice as often as a record daily low for 2000 and 2009. While the record shows some of the . tada daa wait - the world are warming faster than others, the long term global upward trend is -What is that word? -((Translator Note: **A** could not pronounce unambiguous)) Of course land and ocean

¹⁴**P:** I think this around here would be important

((**P** points to the text on the screen))

((They are reading: Consequences of a Warming World))

¹⁵**A:** I think it's this one

((**A** pushes **P**'s fingers out of the way and points to a different line))

¹⁶**P:** Twice as often global warming faster than, wait, warming faster than what? ((Highlighting text on screencast: "long term global upward trend is unambiguous"))

¹⁷**A:** Global warming upward trend - I don't know. Nevermind.

¹⁸**P:** What about here, a warming world. Right there ((Highlights the text on the screen))
((Highlighted text on screen: "warming world also has the potential to change rainfall and snow patterns, increase droughts and severe storms, reduce lake ice cover, melt glaciers, increase sea levels, and change plant and animal behavior."))

¹⁹**A:** *Yeah, that is important.* That's the consequences

Phyu starts to fulfill the role of a writer as a result of April's renegotiation. However, rather than performing a mechanical task of merely writing what April dictates, Phyu processes the

information as she writes them down. Phyu shows this by making a judgment call by stating “It doesn’t matter” in reference to a claim April wanted Phyu to write as an answer to their question of ‘What causes global warming?’ (**Turn 10**). Phyu stops writing and places the pen forcefully on the table. Her action appears to be due two reasons: 1) she does not like the writing task and 2) she is not convinced that what she is writing is productive since in her perspective it does not answer their prompt. Her action of putting down the pen and not writing is her way of communicating to April that she does not find the information relevant, a demonstration of her cognitive authority.

Due to their close friendship as evidenced by their banter (**Turns 4-8**), Phyu’s act of defiance of forcefully placing the pen on the table did not fluster April. However, April senses Phyu’s annoyance and thus, April makes it explicit that April will be reading the text first and not have Phyu write it yet (**Turn 9**). In this moment, April is trying to address Phyu’s concern of writing the text verbatim and offers a compromise that Phyu only writes notes or bullet points (**Turn 11**) and then proceeds to read. Although the compromise addresses Phyu’s distaste for writing verbatim, Phyu is still resistant because Phyu does not think that what April is dictating makes sense. Phyu resists once more (**Turn 12**).

The dyad then engages in productive dissent which eventually results in refining their ideas by pushing one another to find textual evidence that better addresses the prompt (**Turns 13-19**). April continues to read and at one moment moves her face close to the screen blocking Phyu’s view. This does not deter Phyu from shifting her posture and head position to be able to follow April’s reading. This is indicative of Phyu’s continuous engagement to the task and her persistence in defending her cognitive stance.

It is also interesting to note that when a word did not make sense (in this case, “unambiguous”) to April and Phyu, rather than copying it as part of their answer they chose to ignore it (**Turns 16-17**). We surmise that April and Phyu’s unfamiliarity with the word leads to their rejection of the word altogether. In a sense, this is also a way that April and Phyu enact their cognitive authority in the moment wherein they do not take a word offered by the computer at face value and instead choose to stick with an answer where they feel they have made their own. In doing so, they exercise their cognitive authority in discerning and deciding what is important to their task.

In this event, Phyu enacts her cognitive authority through her inaction – that is, her refusal to perform her writer role, and action – her persistence in continuing to view the screen despite

April blocking her view, as well as pointing towards the text that she deemed relevant. Phyu negotiated what counted as knowledge by *not performing* what was expected of her and by insisting on what she deemed was relevant information. On the other hand, April enacts her cognitive authority by using the information the computer offers – that is using the material artifact- to defend her own stance. She does so by positioning herself as the reader of the online information (**Turn 9**) and even to the extent of blocking Phyu’s view (**Turn 13**). In **Turns 14-15**, the two girls even engage in a disagreement that was exhibited multimodally through April’s pushing off Phyu’s fingers off the screen. The dyad’s disagreement was only resolved when they finally agreed on the text that addressed their prompt (**Turns 18-19**)

Use of Material Artifacts

Earlier, we posed that the computer acted as an “interactive member” (Kelly, Crawford, & Green, 2001, p. 138) in the case of Betty, Mala, and Sanda. In this example, April and Phyu’s use of the computer highlights how the computer suggested keywords that shaped the discussion and provided evidence to convince one another of their differing views.

Transcript 5.7: What if they ask ‘How does the animals behavior change?’

¹P: What if they ask,why does, how does the animals behavior change?

²A: They die

³P: BEHAVIOR

⁴A: They die, you know

⁵P: That's not behavior ((snappish))

⁶A: They can't behave because they die ((laughingly))

⁷P: Why would they die?

⁸A: Because they lose the forest and everything

....

Transcript 5.7 continued

....

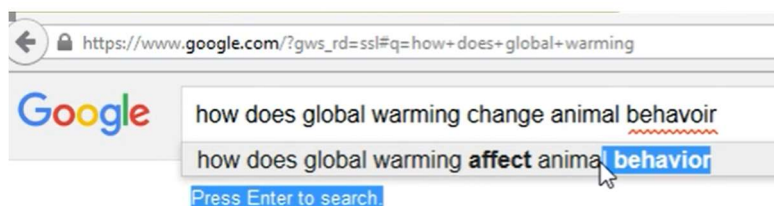
⁹((P types “How does global warming change”))

¹⁰A: How does global warming - What are you writing? Affect the animal, affect the animal behavior.



¹¹A: Right there. You spell affect.

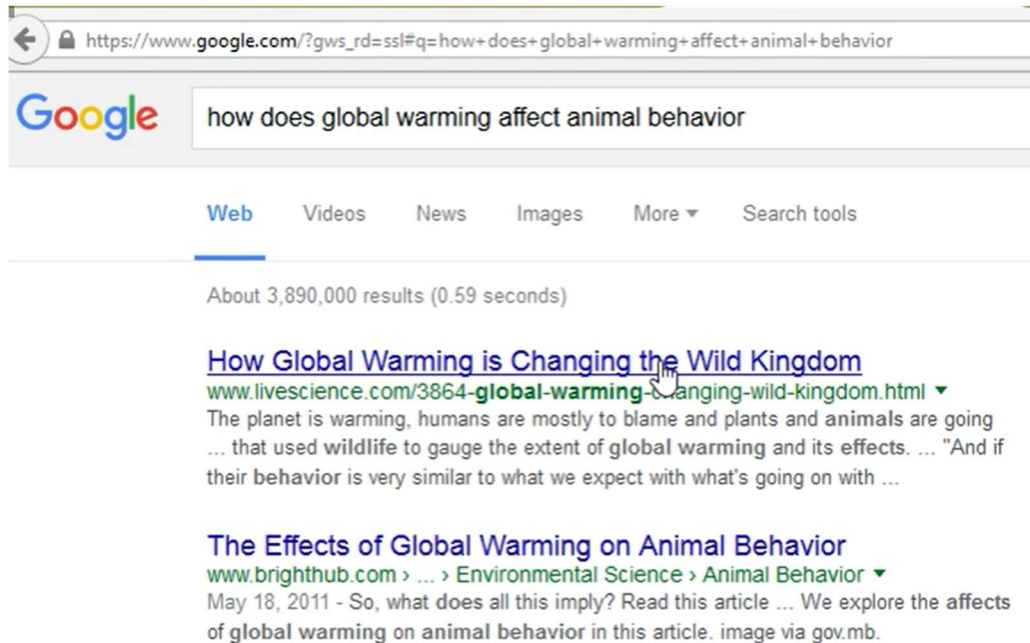
¹²((P continues to type “How does global warming change animal behavior”))



((Google suggests “affect” animal behavior”))

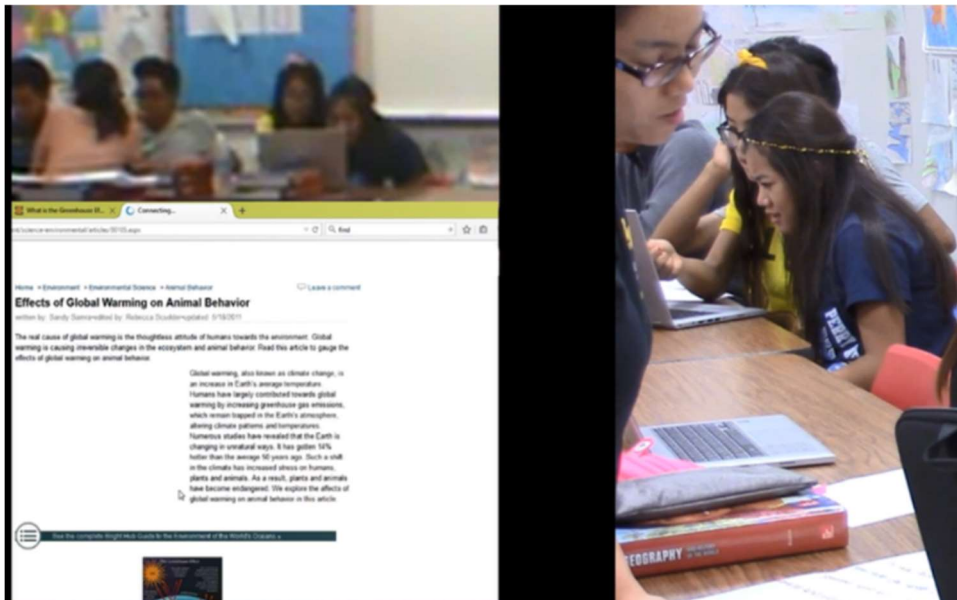
Transcript 5.7 continued

¹³((P chooses the first webpage suggested. Both girls remain silent))



¹⁴((P goes back to the search page and clicks on the second webpage suggested))

((In the image below, A is the girl in blue with a hair crown and P is the girl in yellow with the yellow bow on her hair))



Global warming, also known as climate change, is an increase in Earth's average temperature. Humans have largely contributed towards global warming by increasing greenhouse gas emissions, which remain trapped in the Earth's atmosphere, altering climate patterns and temperatures. Numerous studies have revealed that the Earth is changing in unnatural ways. It has gotten 14% hotter than the average 50 years ago. Such a shift in the climate has increased stress on humans, plants and animals. As a result, plants and animals have become endangered. We explore the affects of global warming on animal behavior in this article.

¹⁵P: Global warming also known as climate change is increase in Earth's average temperature. Humans have largely contributed towards global warming by increasing greenhouse gas emissions which trapped in this (clicking sound) altering climate patterns and temperatures. Numerous studies have revealed that the earth is changing in unnatural ways. It has gotten 14% hotter than the average 50 years ago. tshahsad dada dadada It become endangered. We explore the effects of global warming on animal behavior in this article.

¹⁶A: Yeah, ENDANGERED, the animals become ENDANGERED.

Phyu poses a new question of how animal behavior might change [with climate change] (**Turn 1**). The question holds the possibility of directing the research task in a new trajectory. In her asking, Phyu anticipates what their peers, can potentially ask when they present to the whole group. Phyu's new line of inquiry opens up an opportunity for negotiating what the group holds as relevant information. April shows her reluctance to take up the question as she jokingly replies "They die" (**Turn 2**). We view this as April questioning the value of putting in effort on a question that she perceives has an obvious answer. We also view this as April renegotiating the cognitive authority by her refusal to take up Phyu's suggestion.

Disagreement arises with Phyu differentiating dying from behavior (**Turns 3, 5**), and April sticking with her answer (**Turns 4, 6**) although she delivers this in a joking manner. Phyu presses April for a reason regarding her claim that animals will die (**Turn 7**). April relates the animals' dying to be due to the loss of the "forest and everything" (**Turn 8**). This does not convince Phyu perhaps because April's answer does not give enough details as to how the death of the animals would occur. This conflict is not only an important moment of negotiating cognitive authority but provides an important opportunity for learning (Kelly, Crawford, & Green, 2001). Because Phyu does not take April's answer at face value, they further read and explore the topic to clarify their understanding about how animal behavior changes.

We also note that though the two girls engaged in a cognitive conflict they acted as equal-status members by not engaging in relational conflict. Though they disagreed, they engaged with one another's ideas while maintaining their good rapport with one another. Though both aim to be successful in accomplishing the task and thus argue on their differing ideas, they do not compromise their relationship in the process. This is seen in how freely they joked and talked privately to one another a few moments after this event. This indicates that their disagreement during this task interaction did not strain their relationship.

Phyu persists on the task of figuring out the answer as shown by her typing search words on the computer (**Turn 9**). Phyu uses the computer to enact cognitive authority by remaining committed to her objective. April reads along as Phyu starts to type the search words "how does global warming change" but disagrees with Phyu's use of "change" and instead suggests using the search word "affect" (**Turn 10**). Google suggests several key words to finish the search words and one of them coincidentally is April's suggestion of "affect" (**Turn 11**). In this moment, April highlights Google's suggestion of "affect" as it supports April's suggestion. However, Phyu continues to type out "change animal behavior", sticking to her earlier idea. Google suggests "affect animal behavior" and Phyu eventually chooses Google's suggestion (**Turn 12**). Here, the material resource (the computer) was not merely a mechanical tool but also an "interactive member" (Kelly, Crawford and Green 2001 p. 138) of the group. By taking up the computer's suggested key words, the discussion between April and Phyu shifted.

Phyu chooses the first suggested page (**Turn 13**). They look at the page for 3 seconds but Phyu goes back to the search page and chooses the second suggested page (**Turn 14**). Phyu reads the information on the page audibly while April looks on (**Turn 15**). April emphatically states that

the animal becomes endangered and Phyu is finally convinced (**Turn 16**). Here, the computer provided April the information she needed to persuade Phyu – or another way to look at it is that the computer provided the information Phyu needed to be convinced as to how animals can be affected by climate change. The information the computer provides serves as a medium through which the two girls came to a joint understanding. In this example, April and Phyu strategically used the computer to negotiate cognitive authority by agentively choosing search terms, highlighting information that supported their claims, and ignoring information that they deemed irrelevant or incomprehensible.

Use of Images

Van Eemeren and colleagues (2002, 2004) pose that argumentation is a verbal activity yet other scholars such as Groarke (1996) and Slade (2003) hold that argumentation can be visual as well. Slade (2003) argues that “being reasonable is...a feature of discourse and action” (p. 151) while Groarke (1996) strongly holds that “visual components play a pivotal role in many attempts to prove, convince, or persuade” (p.105). In fact, Groarke (2009) argues that Toulmin’s argumentation model can be expressed in images. Lemke (1998) also supports this view wherein he claims that scientists use a semiotic combination of text, mathematical expressions, diagrams, images, etc to argue their views. In this sense, visual images do not simply restate the meaning of written words (Lemke, 1998). Indeed, images provide “thick description” (Geertz, 1973) by virtue of a picture’s ability to provide “vivid presence, realism and immediacy in perception” (Kjeldsen, 2013). In this section, we demonstrate the various ways learners used images to negotiate for cognitive authority in various contexts.

Triad 2: Tom, Paul, and Moe

We revisit **Transcript 2** where Moe asked for further clarifications on the difference between smog and fog. In this event, Moe specifically asked to look at the pictures to find evidence for the difference between the two (**Turn 1**). Paul mentions that “Smog is poison cloud” possibly due to the image of cars and the picture of a person wearing a mask (**Turn 2**). Tom asks to see the images of the fog again in order to compare the images between fog and smog (**Turn 3**). Immediately, Moe concludes that “smog is due to cars” and “[fog] is natural”, and due to water.

Although, their earlier reading of the texts could have helped Moe process the information, comparing the images one after the other had assisted his understanding of the difference between smog and fog. It is evident in this case that the use of images has assisted Moe in negotiating his understanding of the phenomena. This idea is further clarified when Tom adds an additional detail that “[fog] contains water” but “is not actually water” (**Turn 7**). Using Tom’s suggestion, Moe operationalize a definition the boys had earlier read in the text assisted by the image (**Turn 13**).

Triad 3: Valerie, Jin, and Dan

Valerie (**V**), Jin (**J**), and Dan (**D**) had the task of researching what causes global warming. When MJR checked on their progress, they talked about how greenhouse gases and carbon dioxide, in particular, was the cause of global warming. However, upon **MJR**’s probing, they were unable to provide a mechanistic explanation on how carbon dioxide made the earth hotter. **MJR** leaves the group and the group engages in a discussion.

Dan talks about a protective layer of the atmosphere that protects the earth from the heat of the sun. Valerie and Jin have a hard time understanding his explanation. Dan switches to Hakha to explain and uses gestures. Finally, he draws an image to highlight the mechanism of how carbon dioxide blocks the heat from escaping the “protective layer”. Valerie and Jin indicate their understanding through their nodding and grunts of agreement. Jin takes the pen from Dan and uses the image Dan drew to point out that they do not have a word for the “protective layer”. Valerie decides to put an “X” and look for the term.

The following excerpt shows what transpired as the group made efforts to search for the name of the protective layer and at the same time discuss their emerging understanding of how carbon dioxide contributes to global warming.

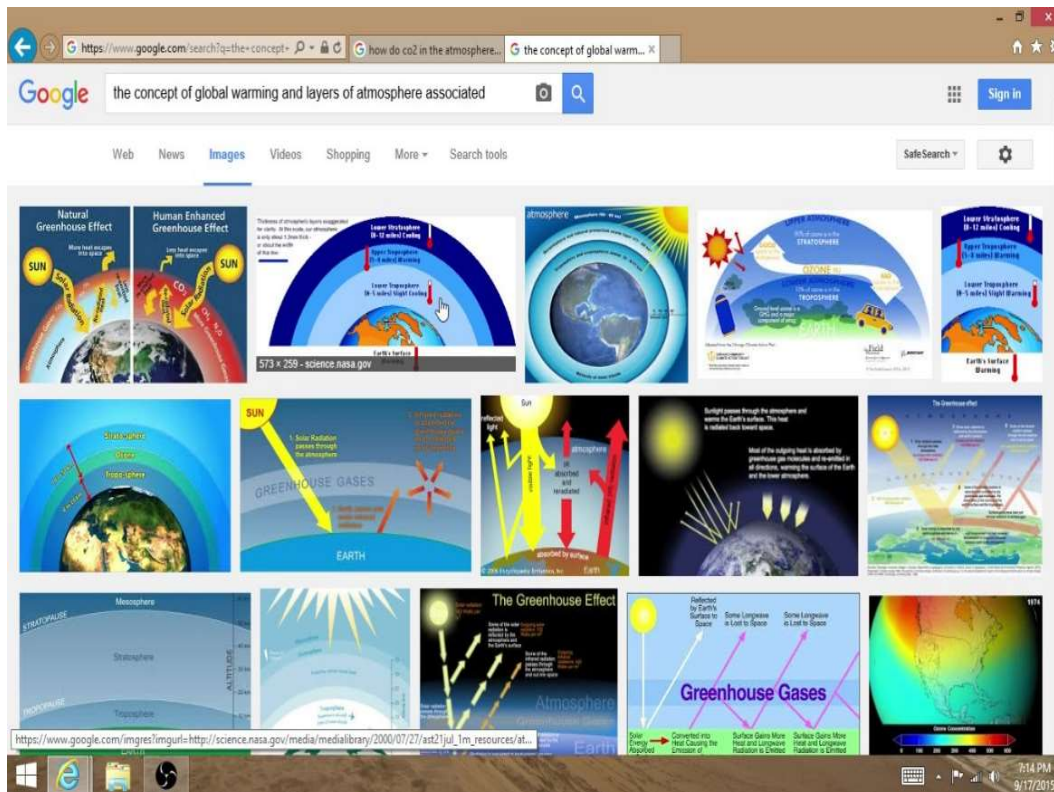
Transcript 5.8: The Good Ozone

- | |
|---|
| <p>¹V: So we'll just Google. Let's go to Google
((The screen changes to Google))</p> <p>²V: ((Spoken in a languid manner with a valley girl affectation)) The concept of global warming ((V types the search words as she speaks them))</p> <p>³J: Or you can also - hold on, let me write something
((J types in his personal laptop))</p> |
|---|

Transcript 5.8 continued

4V: ((V types and sings)) And layers of atmosphere associated

((V clicks on the Images tab))



((V moves the mouse around images))

5J: In this str--tosphere, ((J's gaze shifts between the laptop and the worksheet as he reads and writes))

6V: So solar, solar radiation.

7J: ((Writes)) We, we find the ozone that protects life on earth from ultraviolet rays

8V: You're right, Dan, Dan

9D: Hmm?

10V: You are right

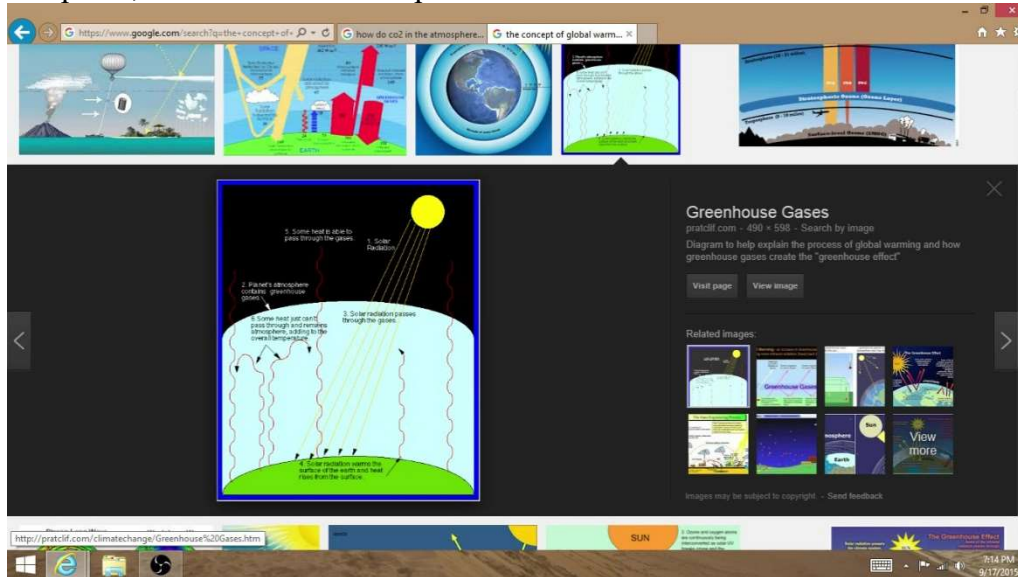
11D: Of course I am

12J: ((Reading)) Thinning the ozone

13V: Your name's not here you know

14J: I think it's called the stratosphere

15V: Stratosphere, what does the stratosphere do?



16J: it's the good ozone that protects the earths from ultraviolet rays. This is yeah.

17V: Okay, okay, alright

18J: Stratosphere. So she[MJR] was saying the sun got in right. Yeah and so and then carbon dioxide blocks it



19D: Yeah, no, the heat got stuck in there. So it blocks it.

20J: Yeah, carbon dioxide blocks it, so the heat cannot go out and it causes the earth temperature to rise

In this example, Dan had an idea of how carbon dioxide traps heat in the atmosphere, a possible answer to the group's new micro-goal of answering MJR's question as to how carbon dioxide makes the earth hotter. As the acting leader of the group, Valerie does not take Dan's answer at face value though she recognizes the importance of this information. Valerie turns to Google to look for the answer but instead of searching texts, she searches for images instead. Valerie finds various images that offer similar ideas – that of the heat of the sun getting trapped in the earth. She acknowledges Dan's contributions as she declares that Dan is right (**Turn 8**). When Dan retorts "Of course I am" (**Turn 9**), Valerie points out that his name is not "here", referring to the Google image. Valerie points out that the idea does not belong to Dan originally but is authored by someone else. This appears as Valerie's attempt to regulate her and Dan's status.

Meanwhile, Jin looks for information as to the name of the protective layer (**Turn 5**) on his personal laptop computer. The computer allows him to access internet information and he finally comes up with "stratosphere" (**Turn 14**). Valerie asks for more information regarding the stratosphere and Jin clarifies that it is the "good ozone that protects the earth from ultraviolet rays" (**Turns 15-16**).

Though Valerie does not say more in the example excerpt, it is evident in a later conversation with MJR that she has taken up the ideas both Jin and Dan had offered. When MJR checks back on them, Valerie shows MJR the picture Dan had drawn¹⁸ and tells MJR "...so heat is coming from the sun, right? And so like it goes in. But if there are carbon dioxide in the air, like it's hard for the heat to come out from the [stratosphere]". We posit that Valerie was convinced of the accuracy of Dan's idea when she saw a similar mechanism being offered by Google. Hence in this moment, the images were useful in the negotiations of the group's co-construction of knowledge. Moreover, the transformation of modes as evidenced by the shift from English utterances (Dan's explanations) to Hakha utterances and gesture (Dan's explanation) to images (Dan's drawing) is indicative of learning. This transformation was also evident in how Valerie searched for texts then images and finally explained to MJR their learning through utterances and use of Dan's drawing as a disembodied mode.

¹⁸ We cannot retrieve the drawing but it was captured in the video and implied in the utterances that Valerie was referring to the drawing Dan had made earlier.

We point out that though Dan had a sound idea that convinced Jin during their group discussion, Valerie as the acting leader and therefore the one with higher status in this interaction took it upon herself to confirm the accuracy of information Dan offered. Though it can be argued that Dan was the originator of the idea, Valerie acted as the spokesperson of the group as she offers the answer the group has come up with to MJR. Though in majority of the group's interaction within the group and outside the group, Valerie maintained high status, Dan's authoring of the idea was acknowledged by Valerie. In this way, Dan was able to renegotiate his status in earlier moments wherein he was a more passive contributor. However, whether this translates to his status within the collective is a different matter – since these things need to be acknowledged in the whole group as well.

Summary

We gave multiple examples on how learners negotiated cognitive authority or what counted as accurate and relevant information in their learning tasks. In their interactions, learners used multiple modes such as gestures, material artifacts, and images to communicate agreement/disagreement towards ideas and persuade one another when there are differing ideas. The learners within the Dyad and Triad 2 generally regarded each other as equal-status members and thus in their negotiations, the negotiations of status were more subtle. There were moments though in the Dyad when April and Phyu were more forceful in their gestures to one another (e.g., April displacing Phyu's fingers off the laptop screen, Phyu hitting the table with the pen in her refusal to write). For April and Phyu who are very close as best friends and cousins, this may be part of their banter.

The example of Triad 3 was quite interesting in such that in the particular case we showed, although Valerie was the acting leader of the group and had access to the computer, she took in ideas of Jin and Dan. This renegotiation is important. We posit that multimodal ways allow learners to negotiate ways of their participation – wherein it must not be restricted to verbal participation alone.

5.9 Conclusions and Implications

The findings of this study has pedagogical implications as to how educators might structure classrooms for more inclusive and equitable science instruction. First, how learners arrange themselves in group work warrants close attention. Proxemics gives us insights as to whether learners are freely able to interact with one another or whether interactions are hindered due to the classroom layout. When learners are struggling for access in their groups, there is an asymmetry of how they seat themselves together and whether certain learners dominate the use of material resources. In such cases, as educators we should be mindful to ensure equity in distributing resources to our learners. If there is a scarcity of resources, at least we must ensure that there is a distribution of access.

Second, gestures, body posture, and affectations of accents and such can clue us in as to learners who may dominate group work. Educators may need to mediate in such moments to ensure that all learners' ideas are listened to and considered.

Third, as shown in multiple examples, roles and cognitive authority are negotiated not only through embodied modes but also through use of material artifacts. Decisive actions (such as writing or not writing) and the flow of information are controlled by whoever holds the pen and paper. Therefore, tasks must be structured to ensure that all members have specific roles to play in group work; otherwise a situation arises where not all members contribute to the output.

Fourth, material artifacts have a status accorded by the learners depending on their function in the group goal or preference of learner's use. In terms of hierarchy, learners accord the most value to artifacts that allow learners to meaningfully contribute to the accomplishment of the goal. Computers are unique resources wherein they can play multiple roles and shape the interactions between learners. Thus, educators must ensure that in structuring learning tasks this special nature of computers are compatible to desired outcomes.

Finally, the use of images as a way to argue and persuade and negotiate for cognitive authority must no be underestimated. We have noticed in several of the groups that learners resorted to using images when texts are incomprehensible. This is a resource that educators must fully utilize in our classrooms.

CHAPTER 6. HOW DO MULTILINGUAL LEARNERS SUPPORT ONE ANOTHER'S SCIENCE LEARNING AND ENGAGEMENT?

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Abstract: With superdiversity becoming the new mainstream in U.S. schools, the ways in which multilingual learners support one another's science learning and engagement warrants better understanding. In this paper, we looked at four dyads comprised of multilingual Burmese youth in an afterschool science program and analyzed their interactions as they collaboratively made predictions about region-specific climate changes in the next 100 years. Using multimodal interaction analysis, we found that the multilingual youth strategically used their linguistic and semiotic resources to create a more equitable learning environment that fosters learning and furthers individual and collective engagement. We offer insights on how youth support one another and prescribe approaches to forward more equitable science instruction in superdiverse settings.

6.1 Introduction

As we move further into the 21st century, changing patterns of migration across the world create superdiverse learning environments, in which various languages, religions, genders, ages, and economic status intersect and co-exist in a complex manner (Vertovec, 2007). Our research is situated in the U.S. science education context within this global superdiversity context.

Moving beyond teaching disciplinary ideas, science educators have highlighted engaging learners in scientific practices, such as asking questions, evaluating information, analyzing data, and arguing from evidence, as a means and goal of science education (NGSS Lead States, 2013). Learners engage in collaborative science practices, in which they share, explore, refine and consider their own ideas as well as others and construct new knowledge from such social interactions. While these practices are promising in promoting learners' scientific reasoning skills and content knowledge, it also implies challenges for minoritized¹⁹ learners who do not have access to participating in collaborative sense-making practices.

¹⁹ The choice of using "minoritized" acknowledges that minoritization is a process and not an inherent characteristic of the learners. It is informed by Benitez's (2010) conceptualization that structural and institutional actions have continuously given limited access to learners who are racially and ethnically different from the norm.

In this study, we focus on learners with resettled refugee backgrounds who are learning science while developing English proficiency. English learners (ELs) in superdiverse U.S. classrooms speak multiple non-English languages, and many speak English as their third, or even fourth, language. Yet instead of leveraging and celebrating learners' multilingualism, English monolingual approaches have served to hinder EL's engagement in science learning (Gutierrez et al., 1995) and have rendered their contributions invisible (Luykx, Lee & Edwards, 2008). ELs, thus, must navigate such multilingual collaborative contexts to achieve specific communicative and sense-making goals.

Our study engaged resettled Burmese refugee high school youth in an afterschool program with the aim of developing their critical STEM literacy (Roth & Barton, 2004). The Burmese youth in the program spoke English and multiple Chin languages (e.g., Hakha, Falam, Zophei) that were not necessarily mutually intelligible. The youth also had varying degrees of fluency in English and in the ethnic Chin languages. Hence, the afterschool setting could be considered a microcosm of a superdiverse learning setting wherein learners spoke a multitude of languages to get their ideas across to peers and facilitators. In our data analysis, we asked: *How do multilingual learners support one another's science learning and engagement?* Through this work, we draw implications for designing science learning environments that afford multilingual youth access to opportunities to engage in science learning.

6.2 Review of Literature

ELs make up 10% of the total student population according to a 2010 report by the National Clearinghouse for English Language Acquisition (NCELA). Moreover, the population of ELs is growing at a much faster rate than the total student population (NCELA, 2010). In fact, while pre-K-12 enrollment increased by 8.5% from the period between 1997-98 to 2007-08; the number of ELL increased by 53.2% for the same time span (Batalova & McHugh, 2010). Meanwhile, across the U.S., there are 381 different languages spoken (Ryan, 2013) pointing to the great linguistic diversity that is now becoming the new mainstream in U.S. schools (Enright, 2011).

English monolingual approaches are contrary to what has been found to be effective instruction that endorses multilingual approaches and recognizes EL's home languages and cultures as rich resources for learning (Wright, 2015). A lot of studies point to how teachers and students move between languages to teach and learn (see: Creese & Martin, 2003; Gajo, 2007). In

fact, research shows that English language learners who leverage some of their home languages (L1) perform better on standardized tests of English reading and other content areas compared to those who are instructed solely in English (Lindholm & Aclan, 1991; Riches & Genesee, 2006; Slavin & Cheung, 2005). Yet, schools continue to “bow to political and ideological pressures to keep languages pure and separate” (Lemke, 2002, p. 85)

The promotion of English monolingual practices has implications for equity. “Using one language and excluding many others...creates divisions, inequalities, and inequities, because it means that [many] are forced to learn... through a language in which they are not proficient” (Kosonen & Benson, 2013, p. 2). It limits the learning opportunities of multilingual youth and contributes to their minoritization. For example, several studies have shown that ELs have insufficient access to advanced-level courses such as honors and advanced placement (AP) courses (Callahan, Wilkinson & Muller, 2010; Harklau, 1994; Kanno & Kangas, 2014)

Another criticism of the current alternative programs for ELs is that they are short term programs that do not allow learners to acquire academic language needed to succeed in mainstream classes (Cummins, 2000). It takes two to five years to acquire basic conversational fluency and five to ten years for learners to develop competency in academic language (Cummins, 2000). Meanwhile, typical duration of participation in newcomer programs are one to three semesters; one year for structured English immersion programs while ESL and sheltered instruction typically range from one to three years (Genesee, 1999). This points to a mismatch in the time it takes for learners to acquire competence in the new language and the support they receive to acquire competency.

With superdiversity becoming the new mainstream, STEM areas in particular require serious rethinking of how ELs are educated. Whereas bilingual education has been implemented for language arts (NASEM, 2018), science and math are usually still strictly taught in English (Boals, 2001). While there are school districts which provide bilingual programs, there is a persistent shortage of qualified bilingual, ESL, and science teachers especially in high needs areas (Institute of Medicine, 2011). Science teachers report feeling least prepared to meet the needs of EL students over any other student group (Banilower et al., 2013). Secondary science teachers, in particular, often teach out of the area they are qualified to teach and thus rely heavily on textbooks as instructional resources (Ceglie & Olivares, 2012). While many secondary textbooks have been updated to provide modifications and supports for ELs, most still focus on science content that do

not incorporate current evidence-based understandings of supporting EL learning (Smith, Hanks, & Erickson, 2017). But the greatest challenge is arguably the linguistic diversity that makes it unfeasible for school districts to provide meaningful science instruction to multilingual learners (McFarland et al., 2017). When the number of learners speaking a certain language are small, these students often do not receive bilingual instruction (McFarland et al., 2017).

Yet keeping learners in specialized language programs is not a viable solution either as it limits access to academically rigorous curricula (Callahan, 2018; Gándara & Hopkins, 2010). For example, sheltered approach usually offers highly simplified science content. The situation often results in the learners' loss of motivation and interest as well as teachers' lowered expectations regarding learners' abilities (Van Laere, Aesaert & van Braak, 2014). Instead of focusing on science content knowledge, teachers resort to focusing on improving students' reading and writing skills (Van Laere, Aesaert & van Braak, 2014).

Science educators and researchers have developed programs to offer learners meaningful science learning opportunities while *at the same time* developing their English proficiency. For example, the work of Warren and Roseberry at the Cheche Konnen Center has demonstrated that ESL (English as a Second Language) students are highly capable of high level scientific reasoning and problem solving when they are taught in ways that leverage their interests and sense-making as well as their cultural backgrounds (e.g., Warren et al., 2001; Roseberry, Ogonowski, DiSchino & Warren, 2010). However, a lot of other interventions still emphasize learners' ability to articulate their science ideas in English and learning of vocabulary without regard to learners' first languages (Amaral, Garrison, & Klentschy, 2002; Gibbons, 2002; Lynch, Kuipers, Pyke, & Szesze, 2005). Even in non-EL classrooms, there is a strong emphasis on learning science-related terminology instead of creating links on science concepts (Bleicher, Tobin, & McRobbie, 2003). Multilingual learners' scientific contributions are often rendered invisible when they are forced to articulate ideas in their language of display rather than their language of ideas (Luykx, Lee & Edwards, 2008; Bunch, 2014). This points to how learners' science engagement remains mediated by their English language proficiency. We argue that though the intent is great in integrating science content and English language proficiency, we need to find better ways in understanding multilingual learners' scientific contributions – in ways even beyond language.

Recently, the National Academies of Sciences, Engineering, and Medicine (2018) reported promising strategies for supporting ELs in their science learning. They recommend that learners

should be engaged in disciplinary practices, productive discourse, and interactions with others. Furthermore, they recommend that learners should use multiple registers, multiple modalities and to leverage multiple meaning-making resources. This strong push towards a multimodal perspective seeks to meet the expectations of content standards not only in science but also in math and language arts (Grapin, 2019).

6.3 Conceptual Framings

With the shift in towards a multimodal perspective, we agree with Jewitt's (2003) recommendation that we should rethink the ways we evaluate learners' science learning and engagement. Here we posit that multimodal interactional analysis allows us to gain rich understandings of how learners negotiate their science learning and engagement in interactions. In this section, we discuss our perspectives on multimodality, science learning and engagement. We then explicate how we apply multimodal interactional analysis in our investigation of learners' science learning and engagement.

6.3.1 Multimodality

A multimodal perspective promotes that an ensemble of multiple *modes* contribute towards teaching and learning (Jewitt, 2003). *Multimodality* posits that a variety of communicative modes are active in a learning setting and therefore all modes warrant serious attention (Kress, Jewitt, Ogborn, & Tsatsarelis, 2014). This perspective deviates from the prevailing view that language is the main meaning making resource we have and non-linguistic modes (e.g., proxemics, gesture, posture, layout, etc.) are merely embellishments to language.

Modes are ways of communicating and sense-making that are shaped by social and cultural influences (Kress, 2014). Grapin (2019) distinguishes between how modes are defined in EL education and in the content areas. In most EL education literature, modes are predominantly thought of as “the channels through which language is transacted” (p. 32) such as receptive and productive language as well as the skills required to achieve them. For example, listening and reading are thought of as receptive skills whereas speaking and writing are thought of as productive skills (Grapin, 2019). In contrast, in content areas particularly in Math and Science, modes are predominantly perceived as “the range of meaning-making devices used in the discipline, both

nonlinguistic and linguistic” (p.33). In science classrooms. for example, talk is not always the primary mode as students are expected not only to communicate via language but also be able to interpret graphs and create and work with models (Kress et al, 2014). Therefore, in EL education, language is still a privileged mode and as such all other modes are merely there to assist the EL as he/she acquires English proficiency; whereas, in content areas nonlinguistic modes are not merely embellishments to language but essential tools in forwarding the discipline (Grapin, 2019).

Our views on multimodality align more with what Grapin (2019) refers to as the strong version of multimodality wherein modes are not merely scaffolds to assist ELs as they acquire English proficiency. We do so out of the following considerations. First, the science learning setting is an inherently multimodal environment and as such contributes to how learners interact and learn (Jewitt & Kress, 2003). The science learning setting provides rich opportunities for use of the different modes. We take this a step further considering that the learners we work with are minoritized resettled refugee youth who have had limited opportunities to participate and interact in their classrooms (Ryu & Tuvilla, 2018). Research shows that minoritized youth who traditionally do not perform well in school science thrive in informal learning settings (Dierking, 2007; Faircloth & Tan, 2016), improve their science knowledge, and develop positive science identities (Leonard, Chabernin, Johnson & Verma, 2016; National Research Council, 2009). Thus, if we are to understand how multilingual learners forward their science learning as well as that of their peers it would be in a setting where they engage in science more comfortably. We posit that multilingual youth would be able to leverage their competencies that are rendered invisible in formal schooling in a setting where there is no pressure of school and grades.

Second, the variety of representational and communicational modes in the science learning setting and how these contribute to teaching and learning has significant implications for how we traditionally define literacy in terms of reading and writing (Jewitt, 2003). Science learning has traditionally been theorized as a linguistic accomplishment (Lemke, 1990) yet the practice of science requires a much more dynamic interaction with the world than through the structure of language alone. If science is about making sense of the natural world (empirical knowledge), then it is much more of a material endeavor. Therefore, while we recognize the importance of language in science and science education; we also should consider how matter and material practices (such as those tied with apparatuses, artifacts and science instruments) play a significant role in the learning and teaching of science (Barad, 2003; Milne & Scantlerbury, 2019).

We are of the view that science learning should be viewed as a multimodal accomplishment in which all modes are carefully evaluated for their affordances and constraints and the interactions of the ensemble of modes critically interpreted (Kress, 2000). With this standpoint, we take the entirety of the modes without privileging one over the other. By expanding our scope to look at the complexity of modes that learners use to make meanings, we can learn how students engage with science concepts and create the interpersonal connections needed to engage with scientific ideas.

6.3.2 Science Learning and Engagement

Our perspectives on science learning and engagement stems from sociocultural ideas that views learning as including both the individual and the social world (Vygotsky, 1978; Wertsch, 1985). Therefore, learning occurs in the interactions between learners and their peers as well as other learned others (e.g., facilitators, etc.). This view is in keeping with a situated view of learning wherein learners move towards full participation the more they engage in the processes of legitimate peripheral participation with members of the community of practice (Lave & Wenger, 1991). We also build on Rogoff and colleagues' (2003) ideas that argues that the process of participation must be evaluated in terms of the personal, interpersonal, and cultural/institutional. In our analysis, we draw from Scollon's (1998) ideas and view participation as a negotiation of how individuals relate to one another (interpersonal), how they interpret the contexts of their participation and the influences thereof (cultural/institutional), and the identities they bring in those events (personal). Thus, we view participation as a negotiation of how individuals interact with other individuals and their environment (Norris, 2011). To do this, we draw on ethnographic methods to situate our analysis in the various contexts that involve the interactions.

In this work, we explore the *science engagement* of resettled Burmese refugee youth in an afterschool science program as they learned about weather, climate, and climate change. By *engagement* we refer to the "active, goal-directed, flexible, constructive, persistent, focused interactions with the social and physical environments" (Furrer & Skinner, 2003, p. 149) that contribute to learners' notions of competence and mastery in social contexts (Nasir & Hand, 2008). Engle and Conant (2002) contend that *greater* engagement can be inferred when: *more* learners make relevant contributions to the topic at hand; *less* learners are doing off-task activities; there is continued interest on the topic; and there is *greater* coordination among learners. Learners'

coordination to one another is manifested multimodally by alignment of gaze and body posture and an abundance of emotional displays – a phenomena Collins (2004) refer to as synchrony through interaction rituals - and is indicative of collaboration.

To analyze learners' science learning and engagement, we draw on multimodal interactional analysis in which student's meaning making is conceptualized to include modes such as spoken language, written words, drawings, images, gestures, body positioning, and gaze (Norris, 2004). This analytic style has been revealing within science environments (Kress et al, 2014; Wilmes, 2018), showing that students have knowledge from interacting in science spaces that links the procedural practices to the learning of science. Student's comfortability with learning science as well as learners' changing patterns of participation are also revealed through multimodal analysis. For example, learners who are regarded as experts in a setting sit closer and arrange science tools/ artifacts around themselves (Roth et al., 1999; Wilmes, 2018). Use of science materials can indicate being a science person or engaging in science identity development (Kress et al, 2013).

In addition, the youth we work with are multilingual learners who have a multitude of transnational experiences having lived in multiple places – each with their own local contexts of activity where people, capital goods and discourses are freely exchanged. Their languaging practices have been shaped by social, cultural, political, and historical contexts of the places they have lived in and the people they have interacted with (Blommaert, 2010). Thus, multilingual learners use complex languaging practices and multiple semiotic resources when they make sense of phenomena and communicate their ideas (Garcia & Wei, 2014). Garcia and Wei (2014) refer to this practice as translanguaging and in this work we explore this phenomena in our analysis of youths' interactions.

Translanguaging is “the ability of multilingual speakers to shuttle between languages, treating the diverse languages that form their repertoire as an integrated system” (Canagarajah, 2011, p. 401). This ability to pull from an integrated system affords multilinguals the ability to strategically select features that would allow them to communicate effectively (Garcia & Wei, 2014) and fully leverage their resources in problem solving and knowledge constructions (Wei, 2018). Because translanguaging breaks down the divides between indigenous/ immigrant, majority/minority and target/mother tongue languages (Wei, 2018), this is a more equitable approach rather than the imposition of monolingualistic English policies in the learning setting. Thus,

translanguaging empowers both learners and teachers alike as it transforms power relations and instead shifts the focus on the process of teaching/learning and making meaning (Wei, 2018).

With these perspectives, we approached this work through: 1) offering an afterschool program that leveraged youths' multiple competencies 2) encouraging use of multimodal practices and 3) critical analysis of youths' usage of translanguaging and multimodality in their peer interactions through multimodal interactional analysis (Norris, 2004). In our analysis we ask: *How do learners support one another's learning and participation through multimodality and translanguaging?*

6.4 RESET Contexts

Design. Project RESET (Refugee Youth Engaging in Critical STEM Literacy and Learning) was offered in collaboration with a non-profit Burmese community organization, Burmese Center (BC) in Midwest City. Midwest City has one of largest resettled Burmese refugee populations, especially Chin, a persecuted ethnic group in Myanmar. Most Chins in Midwest City live in Bluemountain Township in which BC was located. Bluemountain Township is home to about 40 Chin churches as well as a number of Chin-Burmese restaurants and businesses. There are two high schools in the township, each of which enrolls more than 2000 students, and Chin students account for approximately 15% of total student population. BC offers a year-round afterschool program (College Preparation Program [CPP]) and summer enrichment program for Chin high school youth.

Project RESET was offered as part of CPP. Youth voluntarily enrolled in CPP and met three days per week for two hours in one of the Bluemountain township high schools. During each CPP session, the participants get tutoring from volunteers from local colleges in completing their homework, college application and SAT preparation, and scholarship application. In some sessions, there were structured activities (e.g., guest speakers), but in most of sessions, meetings were not structured. The participants worked on their homework while socializing freely with their peers as well.

We offered Project RESET once a week (one out of three regular CPP sessions) for 24 weeks (11 in the fall, 13 in the spring). While CPP was offered to juniors and seniors, we recruited only juniors with a few exceptions. On average, about 15 youth participants attended the RESET sessions. On the days that Project RESET was offered, juniors had an option of joining our program

or other regular CPP activities (e.g., completing homework). Since RESET participants utilized the first 30 minutes of the 2-hour block to work on their homework, we planned each RESET session to last for 90 minutes.

In designing Project RESET, we drew on recommendations from science education literature that foreground (1) rich resources that learners bring to learning settings (Moll, Amanti, Neff, & Gonzalez, 1992), (2) complementary development of STEM literacy and language competence by engaging in disciplinary practices and flexible use of multiple languages and multimodality (Hull & Katz, 2006; Moje et al., 2001; Vossoughi, 2014), and (3) agentic and critical practices that learners craft to re-figure their relationship with STEM, the world, and people around them (Roth & Barton, 2004). Implied in these recommendations is that science is an integral part of learners' lives, shaped by learners' experiences and sociocultural influences, and manifested in various forms of practices (e.g., lab-based experiments, reasoning from everyday experiences, community engagement; Medin & Bang, 2014; Roth & Barton, 2004). Thus, science learning should aim for more than just the acquisition of scientific facts and include learners' engagement in practices that repurpose the discourses of science to foster learners' science identities and transform their relationship to science and the world. This engagement should and can be accomplished through active and practical utilization of learners' experiential and linguistic resources, among others.

To accomplish this vision of science education, we developed a curriculum *Weather and Our Lives* that enables learners to collaboratively reason about weather, climate, and climate change in conjunction with its relationships to human life and globalization. We selected this topic based on the urgency of promoting climate literacy among youth and the conceptual richness of the topic. The design and implementation of the curriculum adopted the three aforementioned recommendations in various ways. First, over the course of the program, the youth addressed questions like, "what are different weather variables?", "how does climate vary in different parts of the world?", and "what is climate change and what are its causes and impacts on people in different parts of the world?" Toward the end of the school year, the youth created digital stories to communicate with peers and the public via media technology and showed their created digital stories to peers and community leaders. By asking questions relevant to our lives, we hoped to draw on the resettled refugee youth's experiences of living and adapting to life in multiple regions, especially with respect to weather and climate, as well as knowledge about the global and local

contexts. Further by engaging in conversations regarding how we feel about climate change and what we should do to mitigate climate change, we encouraged them to evaluate the changing world and act upon it beyond learning scientific facts. By asking them to create digital stories, we built on local youth practices, such as consumption and production of multimodal texts through social media (Ito et al., 2009).

Second, we designed the curriculum employing a responsive curricular approach wherein learners' ideas and facilitators' insights into their ideas were taken into consideration in the ongoing design and implementation of the sessions (Hammer, Goldberg, & Fargason, 2012). Although we had a curricular weekly plan, we designed the curriculum loose enough to modify the instructional moves and curricular activities depending on learners' engagement and learning in activities. The data we present in this paper illustrate this curricular modification across a few weeks (i.e., we modified Week 17's learning goals and activities based on an unexpected question from a student on Week 14). Within a session as well, we routinely revised activities to take full account of students' ideas and questions and maximize opportunities for scientific sense-making.

In addition, we encouraged the participants to use multiple languages and multimodality for communication with each other and learning new ideas. To this end, we conducted various small group activities (e.g., online research, reading of scientific documents, creation of chart paper posters and presentation, lab experiment, vlogging) along with whole group discussions and games (e.g., jeopardy, charades). In a small group work environment, the participants were required to communicate with those whose English proficiency is different from theirs and/or whose home language is different from their own. Facilitators constantly reminded the participants that they can use languages most comfortable to them (as opposed to English only) and that they should ensure everyone in the group is "on the same page," which inevitably pushed them to use multiple languages and multimodal resources. On one session, we even explicitly asked the participants to explain climate change in their language in order to tell their family members. Use of computer and poster paper presentation also allowed them to interact with multilingual and multimodal texts. We observed that participants frequently utilized non-linguistic resources (e.g., drawing pictures and data graphs, interpreting graphs and pictures online) and multilingual resources (e.g., looking up translation of English words, interpreting to help peers, conversing in a shared language). In this learning environment, we hoped that the participants re-figured their relationship with STEM content and people around them, such as adult facilitators who assumed a knowledge authority.

Language practices in RESET. Youth participants are ethnically Chin originating from Chin State, Burma. According to the cultural profile on Burmese refugees prepared by the Center for Applied Linguistics (2007), the Chin speak 20 to 25 languages which are not mutually intelligible but can be classified into four groups based on Chin geographical location and linguistic similarity. Our youth participants spoke multiple ethnic languages (e.g., Hakha, Falam, Burmese, Zophei, Matu, etc.) as well as English with varying degrees of fluency both in the Chin languages and English.

In the weekly sessions, English, a multitude of Chin ethnic languages, as well as other languages were used in the setting. Three out of the four research team facilitators are multilingual (with L1s= Korean, Filipino, Mandarin). Two Chin facilitators who spoke the Chin youths' languages would often work with less English proficient participants to help in translating texts, facilitating discussions between participants, and translating what participants say in their home language to the research team facilitators. Several participants were learning various foreign languages such as Spanish and Mandarin and would at times practice it in the setting. In addition, because several of the girls professed to watching a lot of Korean dramas, participants would pepper their conversations with Korean phrases.

In RESET there was no English-only policy and facilitators encouraged the youth to use whatever language they preferred. However, the youth seemed to deem English as the language of display (Bunch, 2014). The reason for this appears to be two-fold. First, English is the common language for both facilitators and participants. Second, the youth deemed RESET as a setting where they can practice and improve their English language skills since they often do not have a lot of opportunities speaking English in school (Ryu & Tuvilla, 2018). Several of the youth shared the sentiment that either they do not speak (English) in class for fear of judgment from peers or they are with same language friends so they do not have to speak English.

6.5 Methods

6.5.1 Data Collection

For school year 2016-17, RESET met a total of 24 sessions and collected: 44 video-recordings of RESET sessions (2 camera angles; 90-minutes/session), 82 audio-recordings (various lengths) of small group interactions, 36 digital recordings of participants' use of laptop

(i.e. screencast), and 36 semi-structured interviews (total of 16 participants), audio and written field notes, and participant-generated artifacts (e.g., posters, slide presentations, video projects, etc.).

For this study, we analyzed the video recording of the session, digital recordings of youths' computer use (i.e. screencast), and the posters that youth created. The data is from Session 17 in which participants conducted online research to answer the hybrid of a question two participants posed in a previous session: "What will the earth be like 100 years from now if climate change continues?" and "Are people in different locations affected differently?" Participants formed pairs, chose a city they wanted to study, conducted online research, and prepared a poster presentation to answer the question *What will [chosen city] be like 100 years from now if climate change continues?* Motivated by responsive teaching, we designed this activity to provide learners the opportunity to dive deeply into the question while leveraging their interests in learning about different places. We provided learners the option of choosing from the list of 7 cities that reflected different climates and were also familiar to learners from previous sessions. In addition, learners were also encouraged to work with peers they have not worked with.

We chose data from Session 17 because the task structure prompted intensive interactions between partners. Several of the youths we have interviewed (focal and non-focal youths of this paper) remember the activity to be one of the most memorable activities of the program and reported a sense of accomplishment. Week 17 impacted their understanding of climate change and how climate change affects people and places differently. For Session 17, there were 7 dyads but we selected the 4 focal dyads because these were the dyads where we had good quality data. The non-focal dyads were not completely captured in the video-recordings, did not have any screencast data, and the quality of the audio-recordings were poor. The non-focal dyads worked on the following cities: Barcelona, Spain; Nord, Greenland; and Accra, Ghana. Across the focal dyads, youth spoke more than one language: including Hakha, Falam, English, Burmese, and other Chin ethnic languages. Their stay in the US varied from less than one year to more than 9 years. Within the focal dyads, English language proficiency and comfortability with their multiple languages varied. For example, Lin Bo and Nyein did not share a home language. Lin Bo reported greater comfortability with English, whereas Nyein reported moderate fluency in English but said she she was most comfortable using Burmese. There was no shared home language either in the dyads of Apple and Jon as well as Efraim and Nwe. However, there was enough similarity in

Hakha and Falam to communicate between the two languages. **Table 6.1** shows information about the focal dyads and captures the dyads' varied backgrounds in terms of (1) length of time in the US, (2) reported fluency in English, and (3) shared versus varied first language.

Table 6.1 Summary of Focal Dyads' Information

Dyad	Name	Age (when data was collected)	Grade	How long in the US	Self-reported English Language proficiency	Language Most Comfortable Using	Other Languages	Selected City
1	Apple	15	10	4 years	Mostly fluent	Hakha	Burmese (Limited)	Kuala Lumpur, Malaysia
	Jon	19	10	~ 1 year	Limited	Falam	Burmese	
2	Lin Bo	16	11	8 years	Fluent	English	Hakha, Zophei	Baghdad, Iraq
	Nyein	16	11	4 years	Mostly fluent	Burmese	Lautu	
3	Thiri	17	11	9 years	Fluent	Hakha	Zophei	Sydney, Australia
	Da Zin	16	10	4 years	Mostly fluent	Hakha	Burmese (Mostly fluent), Zophei (Limited)	
4	Nwe	16	10	4 years	Mostly fluent	Hakha	Burmese (Mostly fluent)	Indiana, USA
	Efraim	17	10	~ 1 year	Limited	Falam	Burmese	

6.6 Focal Dyads

6.6.1 Apple and Jon

Having been in the US for about a year, Jon spoke very little English when he first joined the program. Jon had been attending RESET for a month when Week 17 data was collected. He was one of the older participants we have had in RESET. He would usually quietly sit in the farthest corner of the room and take up as little space as possible. In contrast, Apple usually sits in the center of the room, energetically laughing with her close friends, Nwe and Da Zin. Her friends volunteered Apple to work with Jon in researching Malaysia – a place Apple had lived in prior to resettling in the US. In their interactions, they majorly spoke in their home languages of Hakha and Falam which shared some similarities. At one point, Jon also attempted to speak Apple’s home language of Hakha.

6.6.2 Lin Bo and Nyein

Lin Bo and Nyein researched what the climate would be like in Baghdad, Iraq. They approached it by researching historical temperature and rainfall trends. Lin Bo is an outgoing student with an expansive imagination and enjoys science. He is most comfortable speaking English and his dialect Zophei and Hakha. Nyein is soft-spoken and feels her English is not good and that she is “not really good at science” (Interview with Nyein). She is most comfortable speaking Burmese and Lauto. She feels she is better at writing in English than she is at speaking it. Nyein sees the STEM program as an opportunity to practice speaking English. Lin Bo and Nyein did not share a language other than English and they used English in their interactions because of this.

6.6.3 Thiri and Da Zin

Da Zin excitedly volunteered to research Sydney when the activity was introduced. Initially, she wanted to work with her close friends. However, since facilitators encouraged learners to pair up with less familiar peers, Thiri, who also showed interest in researching Sydney became her partner. In the setting, Da Zin actively participates by asking questions and sharing ideas to the

group. She would often crack jokes with her close friends and on one-on-one interactions with other peers. Thiri is very vocal in the setting and often the first one to volunteer answers. She does not have a lot of friends in the setting and would usually work with one close friend. When in small groups, she usually assumes the role of a leader. She does not shy away from arguing her opinions and would engage in debates with other learners. Both Thiri and Da Zin speak Hakha and are fluent in English. In their interactions, they flexibly switched and mixed between the two languages. When facilitators checked on their research progress, Thiri spoke for the dyad.

6.6.4 Efraim and Nwe

Efraim and Nwe were interpreting a graph which showed global temperature with respect to carbon dioxide emissions to make a prediction about what will happen in Indianapolis, Indiana. Efraim is new to the context of the afterschool program and was usually quiet. He speaks Falam and feels he does not speak English well. He has been in the United States for about a year. Nwe is a native speaker of Hakha and has been in the United States for four years. She reports an intermediate English proficiency. They did not share a language they are both comfortable using, but they have some understanding of one another's home language. Throughout the session, they constantly switched between English and their respective home languages.

6.7 Data Analysis

We analyzed video-recordings from four dyads drawing on principles of video analysis (Derry, et al., 2010) from an ethnographic perspective (Knoblauch & Schnettler, 2012). We individually watched unedited video recordings of the session and noted potential events for close analysis. In this initial viewing, we looked for moments when learners had rich interactions with one another that forwarded their scientific thinking. MT (Author1) segmented the session according to activity units (See **Figure 6.1**) and made initial notes on what is happening in each segment. Our analytical focus on dyads' interactions necessitated production of multi-layer videos that were a composite of the salient camera angles (whole group and dyad-focused) and screencast data that featured the focal dyads. From the multi-layer videos that MT and CW (Author 2) created, we then collectively decided which events to closely analyze. We captured events – smaller units of coherent interactions – that started with a trigger, usually a micro-goal that catalyzed learners'

actions and ended with another trigger. MT and CW transcribed the selected moments to capture utterances, gesture, body posture, gaze, computer use (e.g., typing a search term), organization of artifacts and use of space (Norris, 2004). When utterances were spoken in Chin ethnic languages, we had the exchanges translated by translators who come from the same refugee population. We note that since we relied on translation our multimodal transcripts are limited by the following: 1) we cannot attribute timing to when the gestures occurred in relation to the utterance and 2) we are unable to make interpretations as to the register or tonality of the utterances (For example: one translator may translate a phrase as “Guys, this is what we should do” and another may translate it as “Everybody, this is how we should do it”).

Using our multimodal transcripts, we looked at events closely and sought to understand how each event contributed to learners’ task. We looked for instances where learners acted in coordination in one another to achieve emerging goals in the moment. We micro-analyzed the selected events combining multiple insights from research team members, juxtaposing emerging findings with ethnographic information gleaned from other data sources (e.g. field notes, interviews), and constantly revisiting earlier analysis when new insights are made available (Derry, et al., 2010). Analytic notes of the microanalysis of each event were written and we made keywords for the events (e.g., connecting to everyday experience, creation of space for collaboration, disagreement, etc.). Through this iterative process of data analysis, we began to see patterns emerging. We created a matrix to generate themes through constant comparison (Lincoln & Guba, 1985) between events within a dyad or between dyads.



Figure 6.1 Week 17 segmented into activity phases.

6.8 Findings

Week 17 was organized into five segments (See **Figure 1**). In sharing our findings, we focus on Segment 2 (research and poster making) since this is where most of the learners' collaboration occurred. From our analysis, we generated the following four themes: **1)** Learners negotiated language expectations; **2)** Learners engaged in social discussions that promote productive interactions and science thinking; **3)** Learners attempted to forward one another's learning by soliciting one another's ideas about climate change and tasks, and at times engaging in disagreements; and **4)** Learners found multimodal ways to contribute beyond use of verbal language. Since each pair worked independently from other pairs, their collaboration trajectories varied. We share each pair's trajectories and our coding of the themes in **Tables 6.2-5**. The bolded and underlined theme numbers indicate episodes we provide detailed analysis for in this paper.

Table 6.2. Table of Events for Apple and Jon

Segment #. Event#	Time	Apple and Jon: Episode Name	Themes
2.1	00:06:13.18 - 00:09:47.26	"I don't get it"	3, 4
2.2	00:09:44.06 - 00:12:43.06	"You guys are lucky"	<u>1</u> , 2
2.3	00:13:19.08 - 00:16:41.15	Apple and Jon interpret data	3
2.4	00:23:11.29 - 00:26:20.09	Finding Myanmar	<u>2</u> , 4
2.5	00:26:36.17 - 00:29:04.18	" I think it's going to be way up"	-
2.6	00:33:07.07 - 00:36:22.08	Apple and Jon predict what may happen	3
2.7	00:36:51.18 - 00:44:20.34	"Are you not going to draw?"	4

Table 6.3. Table of Events for Lin Bo and Nyein

Segment#. Event#	Time	Lin Bo & Nyein: Episode Name	Themes
2.1	00:08:26.00 - 00:12:00.00	"You can write that down"	4
2.2	00:13:41.02 - 00:15:35.17	"I mean I don't know if there will be information about it"	3
2.3	00:20:58.10 - 00:23:37.24	"It's going up"	<u>3</u>
2.4	00:37:31.13 - 00:41:08.19	"We can't lie about it"	3
2.5	00:44:55.01 - 00:47:39.17	"Is it getting hotter or the same?"	3

Table 6.4. Table of Events for Thiri and Da Zin

Segment#. Event#	Time	Thiri & Da Zin: Episode Name	Themes
2.1	00:07:30.05 - 00:12:21.08	Thiri and Da Zin share resources	4
2.2	00:14:04.02 - 00:19:31.02	"And after we read about climate is we can figure out what might happen"	3
2.3	00:14:04.02 - 00:19:31.02	"..wait, is Sydney like farming, is it popular in Sydney or something?"	<u>3</u>
2.4	00:19:35.08 - 00:23:03.12	"Which one do you wanna do?"	2, 3
2.5	00:23:06.24 - 00:28:43.12	"How long have you been here?"	2, 3
2.6	00:34:57.04 - 00:50:19.19	<i>"This is not for school so it feels better"</i>	2, 3, 4
2.7	00:50:27.26 - 00:54:53.13	"We're being artists now"	2, 4
2.8	00:56:38.17 - 01:00:44.05	"And like she said, ..."	-

Table 6.5. Table of Events for Efraim and Nwe

Segment#. Event#	Time	Efraim and Nwe: Episode Name	Themes
2.1	00:20:02.19 - 00:21:23.10	"No, I mean we are not the same ethnic group"	1
2.2	00:25:50.10 - 00:27:34.27	"It's a bad thing?"	-
2.3	00:27:47.06 - 00:32:13.23	"I don't understand"	3, 4
2.4	00:37:50.24 - 00:43:42.24	"Yeah, I think"	3, 4
2.5	00:50:39.26 - 00:52:33.28	Representing ideas: English writing vs drawing	<u>4</u>
2.6	00:57:59.15 - 00:58:11.23	" Can you tell what this is?"	3, 4
2.7	01:00:48.00 - 01:02:13.28	" <i>Mirang tawng cu na thiam ko</i> (You're good at English)"	1, 2

In the succeeding table, we provide a transcription key for the transcripts we provide in our examples. In addition, we also include still images of video recordings of participants' interactions and/or a screenshot of their computer use. When salient we annotate with a double headed arrow to indicate proxemics, a circle to emphasize the material artifact, and a single headed arrow to show direction of body posture and/or gaze. We also included a series of images to show shifts in movement/ gestures.

Table 6.6. Transcription Key

Symbol	Name	Use
1	Bolded numbers	Turn number
Abc:	Text followed by a colon (:)	Name of Speaker
((Text))	Double parentheses	Annotation of action or description
Text	Bolded Text	English translation of Falam utterance
<i>Text</i>	Italicized Text	English translation of Hakha utterance
<u>Text</u>	Double Underlined text	English utterance
<u>Text</u>	Single Underlined text	Denotes text read from a source (e.g., computer, book, etc.)
[Text]	Text in Brackets	Additional information
	Vertical bar	Indicates co-occurring speech
(.)		Denotes a pause
(hhh)		Audible inhalation/exhalation
***	Asterisk (s)	Unclear speech
:::	Colon (s)	Indicates prolongation of an utterance
ALL CAPS	Capitalized Text	Indicates shouted or increased volume speech


6.8.1 Theme 1: Learners negotiated language expectations.

Language expectations were negotiated both explicitly and implicitly since the youth spoke various languages with a wide range of fluency. The youths who attended RESET longer and had some familiarity with one another knew which of their peers shared their language and which ones did not. Youth who spoke the same language usually worked together but in this particular activity they were specifically told to work with a new person.


Here, we give an example of how Apple and Jon set expectations for the use of more of their respective ethnic languages though they may be dissimilar. Through this interaction, they figured out each other's expertise and limitations, and decided the roles that they play in accomplishing their task. In this event, Apple and Jon have already found a website that partly answered their research question. This conversation takes place around ten minutes since they

started working together. Apple is writing key ideas she found online on their poster paper while Jon is browsing through reference books. The event transcript starts with Jon's utterance. This was the first time in their interaction that Jon initiated a topic of conversation.

Transcript 6.1: "You guys are lucky"

1	<p>((Jon shifts his gaze way from the books and asks Apple a question.)) Jon: How long have you been here?</p> 
2	<p>((Apple keeps writing on the poster paper without making eye contact.)) Apple: <i>Three and a half years.</i></p>
3	<p>((Jon goes back to flipping the book pages)) Jon: Are you junior now?</p>
4	<p>((Apple's arm goes over on Jon's space as she writes)) ((Apple keeps writing on the poster paper)) Apple: <u>Sophomore</u></p>
5	<p>Jon: That means you started from 8th grade? <i>From 8th grade?</i></p>
6	<p>((Apple makes eye contact with Jon)) Apple: <i>You started from 8th grade? I started from 7th grade.</i></p>

Transcript 6.1 continued

7	<p>Jon: Me, 9th grade. ((Jon smiles.))</p> 
8	<p>Apple: Hmmm. ((Apple writes.)) ((Apple turns to Jon.)) Apple: <i>My brother started from 9th grade too.</i> Apple: <i>You are <u>senior</u> now? Right?</i> ((Jon shakes his head.)) Apple: <u>Junior</u>? ((Jon's gaze is somewhere in the distance.)) Apple: <i>You? You have not been here long?</i> ((Jon nods.))</p>
9	<p>Jon: It's been only one year.</p>
10	<p>Apple: <u>WOW</u>, I see ((Apple breaks eye contact as she caps the marker she was using)) Apple: <u>WOW</u>. ((Apple nudges her seat back and reseats herself.))</p>
11	<p>Jon: From Yangon.</p>

Transcript 6.1 continued

<p>12</p>	<p>Apple: <i>Did you guys come from Myanmar?</i> ((Jon nods.)) ((Apple turns her gaze towards Jon.)) Apple: <i>Ahh you guys are lucky. Tsk.</i> ((Apple smacks her lips and leans her head back.)) ((Apple leans closer towards Jon))</p> <div> </div> <div> </div>
<p>13</p>	<p>Apple: <i>You guys didn't go to Malaysia?</i> Jon: If we were in Malaysia, ((Jon flips book pages.)) Jon: we would have learned English and ((Apple's gaze is on Jon as she plays with her hair.)) Jon: would be able to speak but in Myanmar we didn't learn at all.</p>
<p>14</p>	<p>Apple: <i>Kind of but it's the same.</i> ((Apple's gaze remains focused and Jon as she continues to play with her hair)) Apple: <i>All the students are Chin and we always talked to each other in Chin.</i> ((Apple raises her hand as if telling a secret. Jon smiles.))</p> <div> </div>

Jon initiates the conversation with Apple and uses Falam to ask her about how long she has been “here” (**Turn 1**). This appears to be a typical question among immigrant/resettled refugees

as Apple replies in Hakha without further context given that she has been in the U.S. for three and a half years (**Turn 2**). Jon's intent to understand Apple's educational background is made apparent when he asks whether she is a junior (**Turn 3**). Apple replies that she is a sophomore (**Turn 4**). Jon resumes this line of getting to know Apple better and understanding her capabilities when he asks her if she started in 8th grade (**Turn 5**). He attempts to connect with Apple further through shifting from Falam to Hakha to ask the same question (**Turn 5**). Apple misunderstands Jon's question (as noted by the translator) and takes it as a declaration that Jon started schooling in the U.S. in the 8th grade (**Turn 5**). This information is surprising and Apple pauses writing, to turns to Jon and makes eye contact (**Turn 6**). She tells him that she started in 7th grade (**Turn 6**). Jon replies he is in 9th grade and bashfully smiles (**Turn 7**). Perhaps he is embarrassed to be older and being in a grade lower than her. He was 19 at the time of the study while Apple was 15 years old. Apple considers it for a moment when she says "Hmmm," and proceeds to write (**Turn 8**). She turns to Jon and offers that her brother started in the 9th grade to reassure Jon that his situation is not unusual. Apple tries to understand Jon's situation as she inquires whether he is currently a junior to which Jon stares into the distance, not making eye contact with Apple.

We view this interaction as Jon and Apple's first attempt to establish their status as learners. Cohen (1994) pointed out that learners of different *status* – defined as an “agreed-on rank order” (p. 23) - affects how learners participate in cooperative groups. Cohen (1994) categorized status given or assumed by students in cooperative groups as: academic, peer, and societal. *Academic status* refers to positions held by a learner that pertains to academic ability especially in comparison to peers. *Peer status* refers to a learners' “social standing” (Cohen, 1994, p. 32). For example, a learner who is “popular” or “friendly” is regarded as having higher peer status than one who is positioned as “unpopular” or “awkward”. *Societal status* refers to the differences in rights and duties placed the society on certain kinds of people. For example, a “white male” is generally regards as having higher societal status than a “non-white female” due to the differences in rights and duties afforded by the society. In other words, societal status is a measure of privilege. We also acknowledge that these classifications of statuses can overlap.

Academic status is the most influential among all status characteristics in the classroom even beyond peer status and perceptions of attractiveness and popularity (Cohen, 1994) In resettled refugee youths' case, education and migration backgrounds greatly influence academic status. We argue that in the context of the learning activity and the task that the group was aiming to do, a

negotiation on their academic capabilities is necessary to ensure how they will go about in their task. These negotiations of their participation structure learners' expectations with one another as to what they can contribute towards achieving the task.

From their exchange, Apple infers that Jon has not been in the U.S. long (**Turn 8**). Jon informs her that he has only been in the U.S. for a year (**Turn 9**) and Apple exclaims at this revelation (**Turn 10**). Jon then tells Apple that he came from Yangon (capital of Yangon Region and the commercial capital of Burma) (**Turn 11**). This could indicate a bid for a renegotiation of his status in Apple's perception. Jon's direct migration from Myanmar to the U.S. removes the stigma of having gone to Malaysia where refugees settle for a while as they await their final country for resettlement. It can even be argued that this direct migration reveals Jon's social standing in Burma wherein he had access to resources to migrate directly to the U.S.

Apple confirms with Jon whether he (and presumably his family) came directly from Myanmar to which Jon nods his agreement (**Turn 12**). Apple's next action points to an emerging friendship between the two as she tells Jon they are lucky, dramatically smacks her lips and leans her head back. Apple leans closer to Jon taking on a pose of close exchange between friends and confirms that they did not go to Malaysia.

Jon then shifts the conversation to tell Apple that it would have been better to have passed through Malaysia then he would have learned English (**Turn 13**). This shows Jon's worry about his English proficiency which he deems is limiting to his participation. This show of vulnerability causes Apple to offer Jon reassurance that the Chins speak Chin to each other anyway (**Turn 14**). She delivers this while raising her hand as if telling a secret and Jon receives this gesture with a smile. This shift in body posture reveals a renegotiation of their interpersonal relationship from strangers to friends.

What happens next are bids of a similar nature (Transcript not shown). Jon insists on the difficulty of not learning English before coming to the U.S. and Apple telling Jon that the English lessons they took in Malaysia still left them unprepared for what it entailed to live in the U.S. Apple then reassures Jon another time telling him that the Chin use technology and it helps them with their English. Apple would share further that in Malaysia she did not receive much schooling because it was a dangerous situation. Their conversation then shifts back to the activity at hand.

Jon and Apple's conversation in this episode functions as a negotiation of what language to use and status. In the exchange, Jon offers that he did not stay in Malaysia where he could have

learned English. We interpret this is Jon's way of gaining Apple's understanding of his limitations in the ways he can participate due to his difficulties in English. Hence, Apple in effect should not expect Jon to have complete understanding of English texts from websites they may have to read and what facilitators who converse in English may say. However, Apple constantly reassures him pushing back on how Jon is positioning himself of a lower status. Apple insists that she has difficulties as well. This indicates a negotiation between Jon and Apple - with Jon positioning himself as having difficulties in English and Apple as having expertise in English and Apple in some ways resisting that positioning and insisting that they are not much different. We note that his finding is consistent with how resettled refugee youth both subscribed and questioned the conflation of academic ability with English language proficiency (Ryu & Tuvilla, 2018).

This negotiation arguably influences their interactions in various ways. First, it sets the expectation for the use of more of their ethnic languages in their collaboration. Second, this has implications in their participation and the roles they would play in accomplishing the task (e.g., who uses the computer, who writes in the poster, who talks to the facilitator, what other ways each can contribute). Through this process of getting to know each other, they build solidarity, start figuring out each other's expertise and limitations, negotiate what can be expected from each other's participation, and set implicit rules for their collaboration.

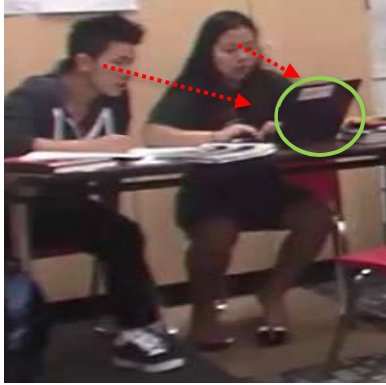
6.8.2 Theme 2: Learners engaged in social discussions that promote productive interactions and science thinking.

Learners in RESET engaged in interactions that did not directly relate to learners' primary objective of answering their science question but created opportunities for increased engagement especially for learners who perceived themselves as hindered in their participation. These off-task interactions not only increased group cohesion but also provided opportunities for additional ways to showcase their expertise. This is reasonable to argue since in Langer-Osuna's (2018) commentary on understanding authority relations in collaborative math groups, it was posited that off-task interactions encouraged collaboration and mathematical thinking.

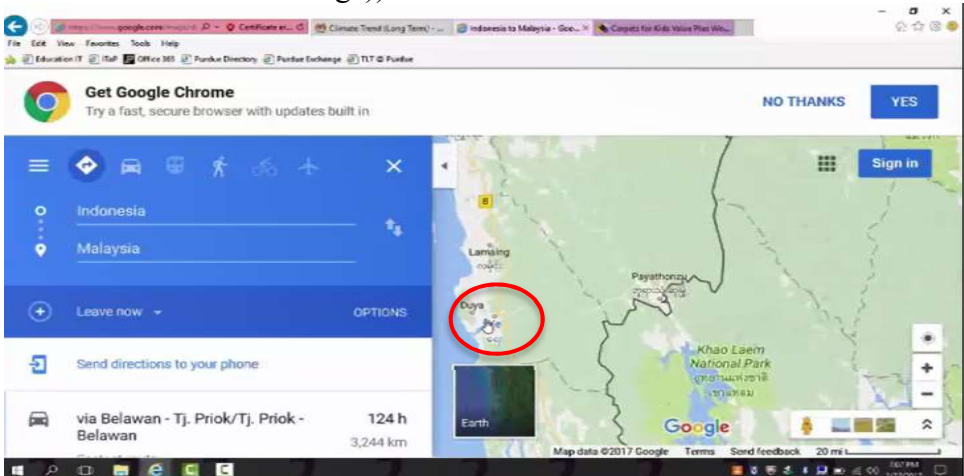
We show an event that focuses on Apple and Jon where they detoured on finding their respective hometowns in Myanmar (another name for Burma) in pursuit of making climate predictions for Malaysia. MT gave Jon and Apple a reference book of climate change in Indonesia and suggested that they look at Google maps to get a reference for the distance between Indonesia

and Malaysia and be able to make comparisons and inferences about how climate change may be like for Malaysia. Apple operates the laptop and puts in Indonesia as the starting point and Malaysia as the destination. She moves the cursor upwards on the map, finds Myanmar, and excitedly exclaims “Ooooooh Myanmar!” Jon also focuses his gaze on the map. As MT leaves the dyad, Apple starts to move the cursor back down to Malaysia. However, the Burmese script under the names of the cities of Myanmar catches Jon’s attention and he asks Apple whether they [presumably Google] can write in Burmese. Apple tells Jon “*Yes, they write it. Naypyidaw* [capital city of Burma].” We share what happens next in **Transcript 6.2**.

Transcript 6.2: Finding Myanmar

1	 <p>((Apple's fingers are on the mouse pad of the laptop. Both teens' gazes are directed towards the screen.)) Apple: <u>Where is it?</u> ((Cursor moves around)) Apple: <u>Where is Myanmar? Where is Myanmar?</u> ((Cursor hovers on the text)) Apple: <u>Tanintharyi</u> [a region in Myanmar] Apple: <u>Myeik</u> [a city in Tanintharyi] ((Cursor hovers on the text))</p>
2	Jon: <u>Tanintharyi</u>
3	<p>((Cursor moves upward)) Apple: <u>Thayetchaung</u> [a township in Tanintharyi] ((Cursor moves upward))</p>
4	Jon: <u>Da wei</u> [capital of Tanintharyi]
5	Apple: <u>Da wei</u>
6	Jon: <u>Kyauk Shat</u> [a village in Tanintharyi]
7	((Cursor moves upward))
8	Jon: *** ((inaudible))


Transcript 6.2 continued

9	<p>Apple: <u>Ye</u> [a town in Mon state] ((Cursor hovers on the text ; Annotation shown on image))</p> 
10	<p>Jon: <u>Duya</u> [a village in Ye]</p>
11	<p>Apple: <u>Lamaing</u> [a town in Mon state] -wha- <u>Lamaing</u> Apple: <u>Pay-</u> ((Cursor moves upward)) Apple: <u>Payathonzu</u> [a town in Karen state] Apple: <u>Mudon</u> [a town in Mon state] ((Cursor moves upward))</p>
12	<p>Jon: In Myanmar, ((Jon slightly leans away from the laptop and then leans forward back to his original position)) Jon: there are so many cities that I don't know of.</p>
13	<p>Apple: <u>Thaton</u> [a town in Mon state] Apple: <u>What? Nyaung Lay-</u> [a city in the Bago region of Myanmar] <u>What?</u></p>
14	<p>Jon: Even Falam [Jon's hometown in Chin State located near the Indian state of Mizoram] and Hakha [Apple's home city and the capital of Chin state] will be there. ((Cursor moves upward))</p>
15	<p>Apple: Falam, <u>yeah.</u> ((Cursor moves left)) Apple: *** ((Cursor moves left)) Apple: <u>Kanthaya.</u> [a village in Rakhine State] Apple: <u>What?</u> ((Cursor moves left and upward)) Apple: <u>Toungup.</u> [a town in Rakhine State] Apple: <u>Right here. Where is it?</u></p>


Transcript 6.2 continued

16	<p>Jon: Falam is not big at all. ((Cursor moves left and upward)) Jon: Hakha and Falam will be at the top.</p>
17	<p>Apple: <u>Is it this way? What?</u> ((Cursor moves right and upward)) Apple: <u>Matupi</u>, [town in Chin State] ((Cursor move towards the text Matupi. Image zooms out)) ((Image zooms back in.)) Apple: <u>Okay</u>, Matupi ((Cursor moves upward)) Apple: <u>Mizoram</u>[Indian State] , <u>Aizawi</u> [capital of Mizoram] ((Apple laughs and briefly glances towards Jon)) ((Job laughs)) Apple: *** Apple: <u>Aizawi</u> ((Cursor moves left, upwards, right, and down)) Apple: <u>Where's Hakha?</u> ((Cursor moves right diagonally)) ((Cursor moves down)) Apple: <i>Hakha is not there.</i></p>
18	<p>Jon: Umm..It's in different place. Make it smaller. ((Jon moves his head closer towards the screen.)) ((Image zooms out)) Jon: Hakha is at the top part along with Falam. ((Image zooms in and zooms out))</p>
19	<p>MJR: <u>Oh my gosh, look at all these fun things</u> [referring to what has already been written on the miniposter] ((MJR sits in front of Apple and Jon)) ((MJR looks at the screen)) MJR: Eehh ((audible gasp))</p>

Transcript 6.2 continued

20	<p>((Cursor scrolls towards Falam; Annotation shown in image))</p>  <p>Jon: *** ((Inaudible))</p>
21	<p>Apple: <u>Right here.</u> ((Apple smiles and puts her left hand over her mouth while her right hand is still on the mouse pad)) ((Cursor hovers over the text 'Hakha'))</p>
22	MJR: <u>What are you looking for?</u>
23	Apple: <u>This is where we lived.</u> ((Apple points to the screen))
24	<p>Jon: Falam will be at the top. ((Jon leans over and points to the screen)) ((Cursor hovers over the text 'Falam')) ((Apple nods))</p>
25	MJR: ((To Apple)) <u>Where are you from?</u>
26	Apple: ((To Jon)) <u>Oh really?</u>
27	Apple: ((To MJR)) <u>Right here.</u> ((Apple points to the screen))
28	<p>MJR: <u>I mean, you're from Falam?</u> ((MJR gazes briefly towards Jon.))</p>
29	Apple: <u>This is from where they are.</u>
30	<p>MJR: <u>How far</u> ((MJR points to the screen)) MJR: <u>are they apart?</u></p>
31	Apple: <u>I don't know.</u>
32	<p>MJR: <u>Have you been here?</u> ((MJR points to the screen))</p>

Transcript 6.2 continued

33	<p>Apple: <u>Yeah, we just passed like, we have to go to,</u> umm, ((Apple's fingers move on the mousepad)) ((Cursor moves downward)) Apple: <u>How do you, where is it,</u> ((Cursor moves downward)) Apple: <u>we have to go to Rangoon,</u> ((Image zooms out)) Apple: <u>like the capital city,</u> ((Image zooms out)) Apple: <u>that's how. we have to go.</u> ((Image zooms in)) Apple: <u>What?</u></p>
34	<p>MJR: <u>So what were you doing? ((MJR laughs)) How did you end up to</u></p>
35	<p>((Jon smiles, leans back)) Apple: <u>Oh, we were searching for Indonesia and Malaysia.</u> ((Jon leans forward to the screen)) ((MJR giggles)) Apple: <u>Yeah, we compared the</u> ((Jon points to the screen))</p>  <p>Apple: <u>climate.</u></p>

MT's suggestion to use Google Maps was intended to help Jon and Apple answer their questions regarding Malaysia. However, the use of Google Maps became an opportunity for them to look for Myanmar. Apple took the initiative to excitedly find Myanmar on the map. Jon shared Apple's enthusiasm when he saw that there were Burmese script on the maps. Perhaps Jon saw this as an opportunity for him to use his expertise in Burmese to contribute to the task at hand.

Apple verbalizes her intent of finding Myanmar by asking "Where is it? Where is Myanmar" (**Turn 1**). This is her way of including Jon in this new group task of finding Myanmar. Apple uses the mouse to navigate the cursor on the Google Map. She then starts reading aloud places on the map. Tanintharyi, a region in Myanmar, is perhaps familiar to her and her cursor moves in an

upward direction when earlier she was just moving her cursor around. Her reading aloud of the places served two functions: 1) an invitation for Jon to contribute and 2) a way to establish a shared understanding of the progress of the task. By reading aloud, it cues Jon as to which region she is viewing and for Jon to follow along.

Jon shows understanding of Apple's intent as he starts reading the names of the places as well (**Turn 2**). They do the same for several turns (**Turns 1-11**). Apple expresses her confusion about Lamaing and Payathonzu (**Turn 11**). This admission that she is unfamiliar with these places puts her in a vulnerable position that possibly served as an invitation for Jon to contribute his know-how. Jon is deeply engaged with the task as his gaze never left the laptop screen. He also comments that there are so many cities that he doesn't know of in Myanmar (**Turn 12**), assuming a position of vulnerability as well that perhaps fosters group cohesion.

Apple continues on to read what appears to be unfamiliar places in Myanmar for her (**Turn 13**). Jon then comments that Falam and Hakha (their respective hometowns) will also be on the map (**Turn 14**). Jon's statement could have prompted Apple to start looking for their respective hometowns. It is also possible that Jon's comment lets Apple know that Jon is now onboard on what she was trying to do and the teens now have a shared goal of looking for their hometowns. Apple's comment on **Turn 15** appear to support the latter proposition when she affirms what Jon said about their hometowns. She continues to read the names of the places, perhaps to ensure they are in step with one another in their search. She then tells Jon that it is "Right here" in English but found it surprising that it is not there. Her use of this simple English phrase directed towards Jon is empowering as it could perhaps be a learning/teaching moment for Jon to feel a little more comfortable with speaking English. Moreover, Apple did not make an assumption that Jon is unable to understand the language he has told her he was having difficulty in.

Jon in **Turn 16** tells Apple in Falam (language) that Falam (his hometown) is not big at all and that both places would be at the top. This moment is an opportunity for Jon to share his expertise and reposition himself as a co-constructor of knowledge. Apple once again replies in English and takes up Jon's suggestions as she moves the cursor upward and in the opposite direction she was moving it earlier (**Turn 17**). By taking up Jon's suggestion, Apple reinforces Jon's position as a co-constructor.

Apple continues to read out the names of places in her search for Hakha, ensuring that Jon is aware of what she is doing. Eventually, Apple tells Jon in Hakha (language) that Hakha (her

hometown) is not on the map. Jon once again shows his expertise of Chin geography as he directs Apple to where Hakha and Falam can be found on the map (**Turn 18**).

At this point, MJR (third author) checks in on their work and expresses her surprise that Jon and Apple are on Google maps since all the other groups have not used this strategy to look at maps (**Turn 19**). The teens remain deeply engaged on the task as Apple finally finds Hakha (**Turns 20-21**). MJR asks them directly what they are trying to find on the map (**Turn 22**). Apple replies to MJR that they are looking for where they lived (**Turn 23**).

Apple's stepping up to answer MJR and through the rest of interactions with facilitators is a result of Jon and Apple's negotiation of contributions and setting of language expectations (Theme 1). Jon for the first time in his interaction with Apple leans over and points to the screen to indicate where Falam is (**Turn 24**). This is the first time he has directly touched the laptop causing the cursor to highlight Falam. This appears to be an evidence of him taking ownership in this contribution. Apple nods (**Turn 24**) and replies to Jon to acknowledge his contribution (**Turn 26**).

Meanwhile, MJR looks at Apple and asks here "Where are you from?" (**Turn 25**) to which Apple replies to MJR (**Turn 27**) only after she has replied to Jon (**Turn 26**). MJR directs a question to Jon verifying if he is from Falam (**Turn 28**) and Apple replies for Jon to confirm (**Turn 29**). MJR queries further how far apart the two places are and Apple says she doesn't know (**Turns 30-31**) and whether she has been "there" [presumably a place on the map] (**Turn 32**). Apple tells MJR that they [presumably along with her family] had to pass by through Rangoon (**Turn 33**). What she implies in her statement is that this was part of her migration path as a refugee. MJR then asks Apple as to how they ended up on Google maps looking for their respective hometowns and seemingly off task (**Turn 34**). Apple reasons that they were searching for Indonesia and Malaysia to compare the climate (**Turn 35**). Meanwhile, Jon points to the screen as a bid to contribute.

This episode demonstrated that off-task interactions provided opportunities for productive engagement. In Jon and Apple's case, their exploration of the map and finding their hometown has helped them care more for their assigned task. It also boosted Jon's confidence by having ways to participate and being repositioned as a knowledge constructor. In the events that succeeded the example, we found that Jon contributed more in their sensemaking as they made predictions about Malaysia's climate by drawing from the things they already know. Thus, their off-task wonderings were generative. It allowed them to draw beyond their initial frame of reference (the internet) and

include things from their day to day lives (funds of knowledge about health, farming, and fishing) in their discussion as seen in **Transcript 3** and in their finished product (**Figure 1**).

Transcript 6.3: Apple and Jon predict what may happen

1	MJR ((to class)): <u>Think about what would happen in animals and human life. Don't say that everything is going to die</u> ((Apple writes on the poster paper))
2	Jon: We will all die in 3000. ((Apple laughs))
3	Apple: <i>I am dying.</i> ((Apple laughs)) Apple: <u>Okay I forgot all of what I just said</u> ugh <i>After she [MJR] left, I forgot all of them. What should we write? Let us just write it this side.</i> ((Apple flips the poster)) ((The case of markers are located by Apple's side and she is the only one with a marker)) Apple: <u>Number 1, sea level is rising. Number two drought cause by the heat from the sun.</u> <i>What would happen? In your opinion, what would happen? Malaysia in a hundred year, what do you think would happen?</i> ((Apple takes out her phone)) ((Apple's gaze is on the laptop as she writes on the poster))
4	Jon: It will get hotter.
5	Apple: <i>What's that?</i>
6	Jon: I think there will be many hardships for people.
7	Apple: <i>Why?</i>
8	Jon: What should I say, umm it will get hotter. I mean the sun will get hotter.
9	Apple: Uhuhmm

Transcript 6.3 continued

10	Jon: Because of that, there will be many dangers for people and there might not be water in many places.
11	Apple: <u>Lots of people will die less population</u> <i>I think it is good. We will do it this way.</i>
12	Jon: People will not die.
13	Apple: <u>Caused by heat wave.</u> <i>And then?</i>
14	Jon: There might be many diseases for people
15	Apple: <u>Living hard because of the farm and</u> ((Apple gazes at Jon)) <i>and what should we say? Let's say <u>seafood</u>.</i>
16	Jon: <u>Sea food</u>
17	Apple: <u>Aquatic animal.</u>
18	Jon: They will die.
19	Apple: <i>There will be less that live inside. Because like aah what is <u>flood</u> in Chin. You know it right. When there is <u>flood</u>, fishes can die and we cannot really eat those dead fishes. So because of <u>flood</u>, there might be less fishes in ocean.</i> ((Jon nods as Apple gestures by raising her hands up and down as she explains to him))

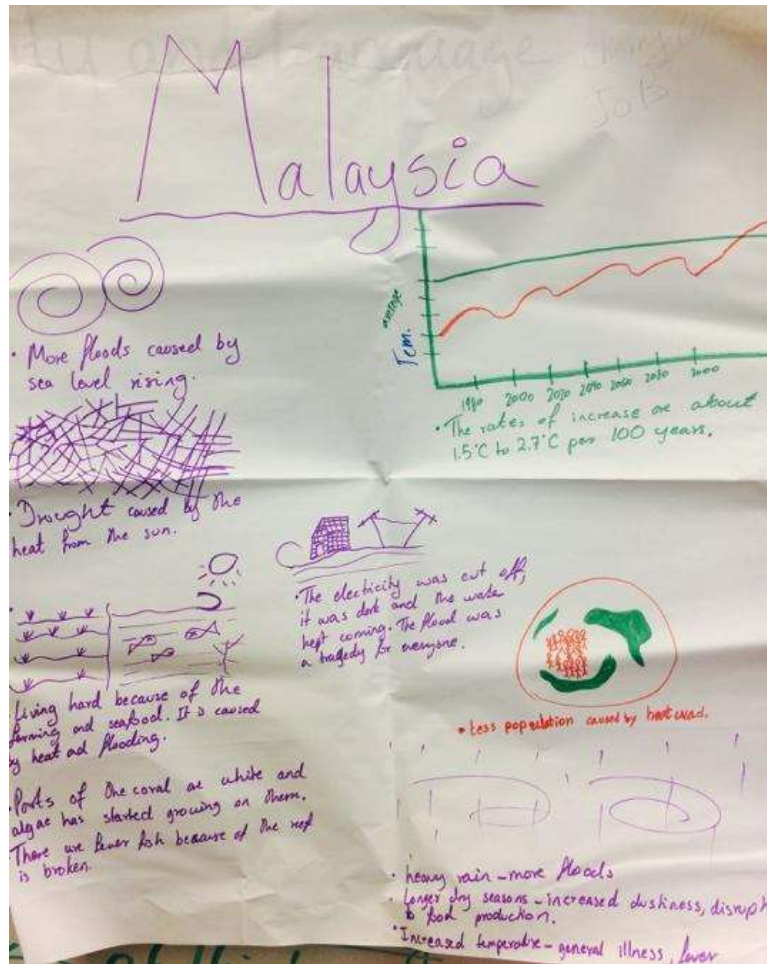


Figure 6.2. Jon and Apple's finished poster. Apple's writings are in purple while Jon's are in orange and green.

In **Transcript 3**, there is greater camaraderie between Apple and Jon as Jon reacts with a joke (**Turn 2**) to MJR's instruction that they should be specific with their examples. In the following exchanges, although Apple does the majority of the writing (see **Figure 1**), she consults Jon as to what to write in the poster (**Turns 3 and 15**) and probes for Jon's reasoning (**Turns 5, 7, and 13**) clearly positioning Jon as a co-constructor of the knowledge they are generating. This positioning is also taken up by Jon as he shares his ideas about how climate change will cause hardships for people (**Turn 6**) due to drought (**Turn 10**) and disease (**Turn 14**). Moreover, Apple takes the time to explain to Jon "seafood", an unfamiliar word to Jon (**Turns 15-17**). In **Turn 18**, Apple forgets the word "flood" in Chin and continues to keep using the English word as she explains her ideas about how flood kill fishes. She understands that though Jon may not have the English word for flood, he understands the idea of flood. More importantly in this episode, Apple



draws on an example from Chin way of life by her seafood example. As she explains it to Jon, she assumes that Jon knows that in Chin when there is flood and there are fishes they cannot really eat it.

6.8.3 Theme 3: Learners attempted to forward one another's learning by soliciting one another's ideas about climate change and tasks, and at times engaging in disagreements.

For the third theme, we share two examples to demonstrate how learners forwarded each other's learning through scientific argumentation. In our examples, scientific argumentation occurred when learners examined and refined their own thinking to both persuade peers of an idea and evaluate available explanations and counter-arguments (Berland & Reiser, 2009). This required learners to negotiate between being a knowledge critic in one moment and a knowledge constructor in another moment.

In the first example, Thiri and Da Zin flexibly used Hakha and English along with gestures and changes in posture as they negotiated between their differing ideas on what to research. MJR had asked Thiri and Da Zin about the impacts of climate change. Da Zin forwards the idea that farmers "couldn't farm" because "there wasn't much of water, there wasn't rain." Building on Da Zin's idea, Thiri asks whether farming is "popular in Sydney or something?" MJR urges them to find out and leaves. The following conversation then ensues.

Transcript 6.4: ‘.wait, is Sydney like farming, is it popular in Sydney or something?’

1	<p>((Thiri and Da Zin are seated a seat apart. The shared laptop is in their midst)) ((Thiri types “Climate in Sydney Australia” on the shared laptop. Her own laptop is on her right)) ((Da Zin’s gaze is directed towards the shared laptop.))</p> 
2	<p>Da Zin: So, <i>why don’t we write about <u>farmers</u> that we just talked about?</i> ((Thiri looks away from the laptop and looks towards Da Zin))</p>
3	<p>Thiri: <i>Do they also do farming in Sydney Australia?</i></p>
4	<p>Da Zin: <i>In what she [MJR] said</i></p>
5	<p>Thiri: Uhuh ((Thiri turns her body towards Da Zin and remains facing her throughout this transcript))</p> 
6	<p>Da Zin: <i>We will write the <u>effect</u> of <u>climate</u> change first, and then with Sydney like, you know we will make that effect <u>connect</u></i> ((Da Zin makes an open palm gesture on the poster paper)) Da Zin: <i>with Sydney. Like with Sydney, does this happen in there as well?</i></p>
7	<p>Thiri : Ahhhh. <u>Do you want to do it like that?</u></p>

Transcript 6.4 continued

8	Da Zin: <i>I guess it is like that. In what she [MJR] just said, we will find climate effects and then see if that also affects and what it's going to be like after in 100 years, I guess it's something like that</i>
9	Thiri: Uhuh. <u>I was thinking we should just like find out how it is like you know in Sydney right now</u> ((Thiri taps on the keyboard. Da Zin leans in towards Thiri)) Thiri: <u>and then uhm the problems that it's facing</u> ((Thiri taps on the poster paper)) Thiri: <u>and then after the problems we can write out what will happen.</u>
10	Da Zin: Hmmm. <u>Yeah, we can do that</u>
11	Thiri: <u>or what you said was all of the climate change problems</u> ((Thiri makes an open palm gesture to Da Zin)) Thiri: <u>and then like similarity</u> ((Thiri makes a circular gesture over the poster paper)) Thiri: <u>to the Sydney Australia problems. Which one do you wanna do?</u>



Da Zin brings up “farmers” as a possible direction to pursue (Idea 1) since they had just talked about it with MJR (**Turn 2**). Earlier, Da Zin posed that farmers could not farm if there was no water. Thiri evaluates Idea 1 and challenges it by suggesting a criterion of relevance – whether farming is also done in Sydney (**Turn 3**). Da Zin offers that Idea 1 aligned to what MJR has said in a bid for Thiri to agree given MJR’s authority as a facilitator (**Turn 4**). However, Thiri’s question pushes Da Zin to recognize this underlying criterion of relevance and reframe Idea 1. Thiri’s rapt attention towards Da Zin as indicated by her body posture (**Turn 5**) encourages Da Zin to share her reframed idea. Thus, in **Turn 6**, Da Zin builds on Thiri’s criterion of relevance and considers other factors of climate change and suggests connecting the effects of climate change to Sydney (Idea 2). Thiri expresses her openness to Idea 2 (**Turn 7**). Da Zin maintains her hedging language to indicate to Thiri that she is open to other ideas but also reminds Thiri regarding MJR’s instructions and stresses that alongside finding the effects of climate change, they also have to predict what it will be like after 100 years (**Turn 8**). In **Turn 9**, Thiri suggests focusing on Sydney and its current problems then making a prediction based on it (Idea 3) to which Da Zin also expresses her willingness to pursue Idea 3 (**Turn 10**). Finally, in **Turn 11**, Thiri restates the ideas that they have at the moment, revoices Da Zin’s idea and seeks Da Zin’s thoughts on which one to pursue. This excerpt shows how the ideas evolved over several turns as Thiri and Da Zin

considered, evaluated, and negotiated between pushing their own ideas forward and being willing to change their mind to consider their partner's ideas.

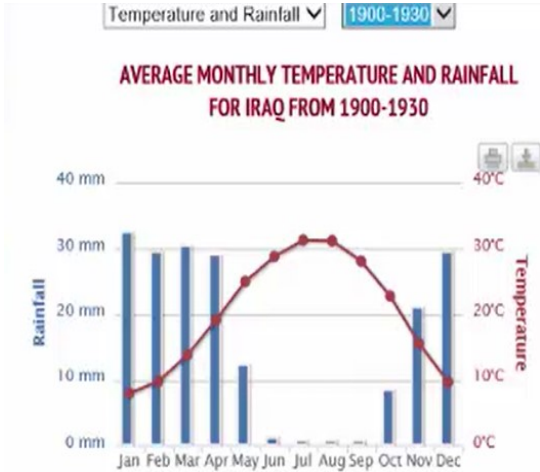

As they engaged in this “exploratory talk” (Michaels, Shouse, & Schweingruber, 2008; NRC, 2007), their flexible use of Hakha and English along with the gestures that punctuate their explications has allowed them to engage in sense-making by conversing in their language of ideas (Bunch, 2014) rather than worrying about how to communicate in English. Their flexible language use has allowed them to “clarify their initial ideas and engage one another to listen, attempt and build on those ideas and adjust or improve on them” (p. 103, Michaels et al., 2007). Their expressions of openness to new ideas and willingness to negotiate was shown in the way they angled their body posture to each other and their utterances expressing agreement (e.g., “Uhuh”, “Ahhh”). This openness has encouraged one another to express their thoughts they may not be certain about and created an environment that supported their equitable participation (Vossoughi, 2014).

In our second example, we look at a disagreement that ensued between Nyein and Lin Bo as they made climate change predictions on what will happen to Baghdad, Iraq 100 years from now. At first glance, Nyein and Lin Bo had what looked like an unequal collaboration in which Lin Bo dominated as Nyein took his direction in creating the poster they were making to represent their work. But earlier in their group work, Lin Bo had taken up Nyein's idea to make the prediction based off data about the climate in Baghdad 100 years ago. Here, they discuss with the facilitator, MT, how to represent the data that led to a disagreement on how to interpret a graph they found on a website about climate change prediction. When this moment begins, Lin Bo is sitting on top of the desk with the shared laptop perched on his lap. He has been toggling the mousepad and interacting with the interface while Nyein looks on and comments. Lin Bo's positioning in relation to Nyein – sitting up on the desk with the laptop on his lap- gives him a more dominant position as he is on the same level with MT, the facilitator. Meanwhile, Nyein sits in a chair, her gaze essentially eye level with the laptop but below where MT is situated.

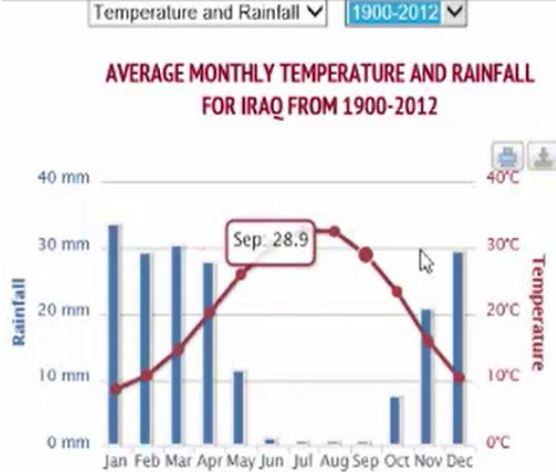
Transcript 6.5: “It’s going up”

<p>1</p>	<p>MT: <u>How does it look like, like so if you change the time period, how does it look like, is it changing?</u> ((MT points to the laptop which is sitting in Lin Bo’s lap)) ((Nyein is seated facing the camera, gazes up at MT as MT poses her question)) ((Lin Bo sits on the desk, gazes down at the laptop in his lap))</p> 
<p>2</p>	<p>Nyein [whispers]: <u>ch-changing</u> ((Nyein leans forward toward computer in Lin Bo’s lap))</p> 
<p>3</p>	<p>((Lin Bo looks at MT)) Lin Bo: <u>If it’s a hundred years later</u> ((Lin Bo looks back at the screen)) Lin Bo: <u>-or now?</u></p>

Transcript 6.5 continued

4	<p>MT: <u>Yeah - why don't you look at 1900 to 1930?</u></p> <p>((Lin Bo clicks on 1900-1930, graph changes))</p>  <p>MT: <u>What is it showing you?</u></p>
5	<p>Lin Bo: <u>To me it looks the same-</u></p> <p>((Lin Bo looks to MT))</p>
6	<p>Nyein: <u>IT'S GOING UP</u></p>
7	<p>MT: <u>It's the same.</u></p>
8	<p>Nyein: <u>It's (.) going (.) up.</u></p> <p>((Nyein leans back and looks up at Lin Bo))</p>
9	<p>MT: <u>Nyein says-</u></p>
10	<p>Lin Bo: <u>All right</u> ((Lin Bo touches his collar))</p> 

Transcript 6.5 continued

11	MT: <u>- it's going up</u>
12	<p>Lin Bo: <u>Let's look at it again</u> ((Nyein pushes hair out of face and leans in toward the laptop in Lin Bo's lap)) ((Nyein points to the graph)) Lin Bo: <u>Thirty right, put your hand on the thirty</u> ((Lin Bo toggles graph. Nyein has her hand on the screen))</p>
13	Nyein: <u>I mean - just a little</u>
14	<p>Lin Bo: <u>And now 2000</u> ((Lin Bo changes graph to show data for 1900-2012))</p> 
15	MT: <u>It's now thirty degrees Celsius</u>
16	Nyein: <u>It was, it was at uh nine or eight</u>
17	<p>Lin Bo: <u>See</u> ((Lin Bo moves mouse over graph as it changes))</p>
18	MT: <u>It's higher</u>
19	<p>Nyein: <u>It's getting a little higher</u> ((Lin Bo mouses over graph, tracing the change))</p>
20	<p>MT: <u>It's higher, right?</u> ((MT quickly moves forward to point at the screen then stands back up))</p>
21	Lin Bo: <u>Yeah, I see it</u> ((Lin Bo leans back))

In this excerpt, Lin Bo and Nyein are deciphering the meaning of historical temperature and rainfall graphs they found about Baghdad. In **Turn 1**, MT asks them to compare time periods using the graphs. Nyein whispers that the graph changes as she leans forward to examine the graph on the screen on Lin Bo's lap, offering her interpretation of the graph in a hesitant manner due to its lower volume (**Turn 2**). Lin Bo looks to MT to request clarification if she wants them to

interpret if the graph is in the current time or if she wants them to predict what will happen in 100 years (**Turn 3**). MT suggests they look at the time frame from 1900-1930 and Lin Bo clicks on that trend, the graph changes to show the temperature and rainfall data for that time period and MT asks them to interpret it (**Turn 4**). Contrary to what Nyein has just stated in **Turn 2**, Lin Bo states that it looks the same to him (**Turn 5**). Lin Bo appeals to MT as he answers, turning to look at her. Nyein disagrees, asserting that the graph is going up (**Turn 6**). MT repeats Lin Bo's assertion (**Turn 7**), but Nyein restates her claim in a punctuated and even tone, looking up to make eye contact with Lin Bo as she does (**Turn 8**). MT restates what Nyein has said (**Turn 9, 11**). MT's speech overlaps with Lin Bo who touches his collar as he is challenged by Nyein (**Turn 10**). Lin Bo suggests that they look at it again (**Turn 12**) clearly asking for evidence to persuade him to change his stance. As Lin Bo and Nyein are in disagreement at this point, Lin Bo's use of his position perching the laptop on his lap affords him information that he can use to control the direction of their argument. Lin Bo then directs Nyein to put her hand on the thirty on the graph (**Turn 12**) as he toggles the interface to the other graph so they can compare the graphs from different time points. Nyein refines her assessment of the graph stating that it has [changed] "just a little" (**Turn 13**). By doing so, Nyein acknowledges Lin Bo's point yet clarifies her view point that though "just a little" the graph is changing. Lin Bo further interacts with the graph, clicking on data for 1900-2012 to compare to the data for 1900-1930 (**Turn 14**). MT states that it now reads 30 degrees (**Turn 15**). Nyein refines her argument further, claiming with specific numbers ("nine or eight") what the temperature had been before (**Turn 16**). Lin Bo attempts to provide a counterargument and evidence by his bid for MT and Nyein to direct their attention to the graph as he traces the change (**Turn 17**). MT takes up Nyein's claim, restating that it is higher (**Turn 18**). Nyein restates her claim that the temperature changes on more specific terms: "It's getting a little higher" as Lin Bo makes use of the graph, tracing the path of the change in temperature to confirm (**Turn 19**). MT requests affirmation of Nyein's claim (**Turn 20**), to which Lin Bo concedes the point (**Turn 21**). As he concedes, Lin Bo leans back slightly giving up some space was occupying (**Turn 21**).

Lin Bo and Nyein engaged in productive disagreement about the graphical representation of the temperature trends in Baghdad over the course of the last 100 years so they could make a prediction about the next hundred years based on evidence. They listened to one another's ideas and made arguments from the graphical data they had on the laptop. Periodically throughout this

moment, they adjusted their body positioning to better address the task at hand and to gesture to the data they are interpreting on the laptop.

By confronting counter-explanations, learners refine their understanding of science content and develop stronger arguments (Kuhn, 2010; Sampson & Clark, 2009). Nyein clarifies her argument as Lin Bo disagrees with her. As they examine the graph together, Lin Bo remains in control of the interface, giving him more power over assessment of the graph. Yet as they place their hands on the graph and use the cursor as an extension of their pointing gestures, Nyein concedes her point slightly and Lin Bo looks further into the data. Their interaction with the graph allows them to come to a greater agreement on what it represents.

These examples demonstrate that learners support and sustain one another's science learning and engagement through openness to one another's ideas and pushing each other to clarify their thoughts, even if it leads to disagreements. They communicate in ways that allow them to make full use of their communicative modes – whether through translanguaging or use of multimodality – so as not to restrict the ways they discuss their science ideas.

6.8.4 Theme 4: Learners find multimodal ways to contribute beyond use of verbal language.


For the fourth theme we focus on how learners made use of non-verbal or paraverbal modes to contribute to sense making within their groups. We recognize that the communicative meaning of an action is arrived at through all modes in conjunction with one another (Kress, Jewitt, Ogborn, Tsatsarelis, 2014). Here, we place our analytic lens on the importance of other modes beyond language to show youth's knowledge and contributions.

In this example, Efraim who was collaborating with Nwe used gestures, material resources, and his home language (Falam) to contribute to his group's prediction for the climate in Indianapolis. While Nwe and Efraim do not share a common L1, earlier in this session, they negotiated that they would be able to communicate using their respective home languages if necessary as they can somewhat understand one another's language. As they are interacting with MJR, who does not share their home language and speaks to them in English, they use English for the ensuing interaction. We focus on the relevance of modes beyond English to make sense of their contributions.



Just before the event begins, Efraim found a website that has information directly related to climate predictions in Indianapolis and handed his laptop to MJR so she and Nwe can see it, thereby sharing resources to further the group’s work and showing his engagement in the prediction task. While Nwe and MJR are speaking about the data on the screen, Efraim shows attentive behavior by leaning in and directing his gaze towards Nwe and MJR. Nwe begins by examining the differences between trends on the graphs, but expresses uncertainty as this task requires her to make use of the word “emission” she has just recently learned. As this example begins, MJR prompts them to interpret the data after explaining what “emission” means.

We note that this analysis is based off on video data only as we do not have screencast data of the laptop they were using because Efraim used his personal computer in this interaction.

Transcript 6.6: “I don’t understand”

<p>1</p>	<p>((Efraim, MJR, and Nwe are seated at the corner of three desks with MJR seated in the middle and Efraim to her left and Nwe to her right)) ((Efraim, MJR, and Nwe direct their gaze toward the laptop which is on the desk in front of MJR))</p> 
<p>2</p>	<p>MJR: I think so, yes, let’s see so this one, this color means what? Lower emission, higher emission, days that are over 90 Fahrenheit, I don’t understand exactly what this graph represents, what do you think? So – ((MJR points to screen, places hand on chin))</p>

Transcript 6.6 continued

3	Nwe: Th- uh err –
4	MJR: – The orange, yeah –
5	Efrain: – there uh twenty-seven ((Efrain points to computer screen)) 
6	Nwe: I think this is temperature- ((Nwe points to screen))
7	Efrain: Temperature ((Efrain moves hand to point at different part of screen))
8	MJR: temperature but
9	Efrain: Forty. Umm
10	MJR: Wait no, it says it's day per year over 90 Fahrenheit so it means that on this year the days that are over, the temperature is over 90 degrees is 80, isn't it?
11	Nwe: I don't, I don't understand. ((Nwe touches hair, leans back.)) ((MJR looks at Nwe, touches neck)) ((Efrain leans back, touches neck))  Nwe: It's kind of complicated ((Nwe laughs))
12	MJR: It is yeah, it is, it's hard ((Efrain leans forward again to look at computer)) ((Nwe laughs, leans forward to look at computer again))

Efrain, MJR and Nwe are oriented toward the laptop which is placed directly in front of MJR, who is seated in the center (**Turn 1**). MJR draws Nwe and Efrain into interpreting elements of the graph by asking about what the orange parts represent. MJR gives a few ideas but hedges

her language, thus, positioning Nwe and Efraim as knowledgeable by expressing her uncertainty and asking for their ideas (**Turn 2**).

Nwe clarifies that MJR is indeed asking about the orange part of the graph (**Turns 3-4**) and offers that she thinks it is temperature and points to the screen (**Turn 6**). Efraim points to the screen and reads “there, uh twenty-seven” then “temperature” and “forty” (**Turns 4, 6, and 8**). Efraim, Nwe, and MJR collaboratively juggle multiple subtasks needed to understand the graph. Each individual point out parts of the graph that they think is important or can make sense of: Efraim looks at numerical values, MJR looks at color coding, and Nwe looks at labels [temperature]. Their contributions illustrate the complexity of interpreting scientific information which requires negotiation across symbolic representations such as graphs, numbers, color, and labeling (Kress et al., 2014).

MJR states that the graph cannot be about temperature alone as there is the representation of how many days are over 90 degrees [Fahrenheit] (**Turn 10**), contradicting Nwe’s interpretation that the graph is about temperature alone. During this moment, MJR, Nwe, and Efraim are leaned in looking at the computer with the graph on it. They show that they are collaboratively working to understand the data by reacting in a coordinated manner (**Turn 11**). When Nwe says that she does not understand, all three lean back and touch their necks, using gestures and proxemics to echo one another’s uncertainty (**Turn 11**). They then lean back in to work at interpreting the data as MJR agrees that it is “hard” (**Turn 12**). This coordination of their bodies shows the importance of bodily coordination in making sense of data, where the socioemotional aspects of collaboration such as echoing others feelings in interaction are important for maintaining group cohesion and group membership (Collins, 2004).

MJR and Nwe then discuss the text associated with the graph. Efraim leans in and directs his gaze toward the computer during this time, showing his continued engagement. The following transcript shows the interaction as MJR is getting up to leave Efraim and Nwe to work.

Transcript 6.7: Continuation of Transcript 6.6

1	MJR: ... <u>What's the impact of climate change that you are seeing here?</u> <u>What do they say here?</u>
2	Nwe: Ohhh a lower emission, like it's less a day but, for the higher it's like – Ah, <u>I don't know</u>
3	MJR: <u>Okay, so spend some time – I think this website is right, good job finding this</u> ((MJR looks at Efrain)) MJR: <u>Okay, so just read through and think about it and talk to each other to figure it out. I think you do have an idea, so, um, okay?</u>
4	Efrain: It's been one hundred years, right? In 2070, the temperature is 40, and after that at 2099, it's 80. The way it increases...

MJR asks Nwe to give an interpretation of the graph based on the text (**Turn 1**). Nwe expresses that she still does not know what the data says about climate change (**Turn 2**). Efrain responds with an explanation of the graph in Falam – showing not just his understanding of the discussion Nwe and MJR have just had, but also that he has some understanding of the meaning of the graph and can explain it to Nwe in his home language (**Turn 4**). Moreover, Efrain makes use of his linguistic resources to offer Nwe an explanation in his home language. Nwe had a better grasp of the graph due to Efrain's explanation that the conversation Nwe just had with MJR in English.

Efrain's description is linked to the graphical representation as he references specific temperatures and dates. The significance of these graphs for their prediction is evident when examining the poster they created (**Figure 6.3**). On the upper righthand corner of the poster, they have a bar graph with orange and gray bars labeled with a range of years on the x-axis and unlabeled numbers on the y-axis. While we do not have access to the website graph via screencast data for this group, we believe that this is a representation of their interpretation of that graph based on the scales and color choice.

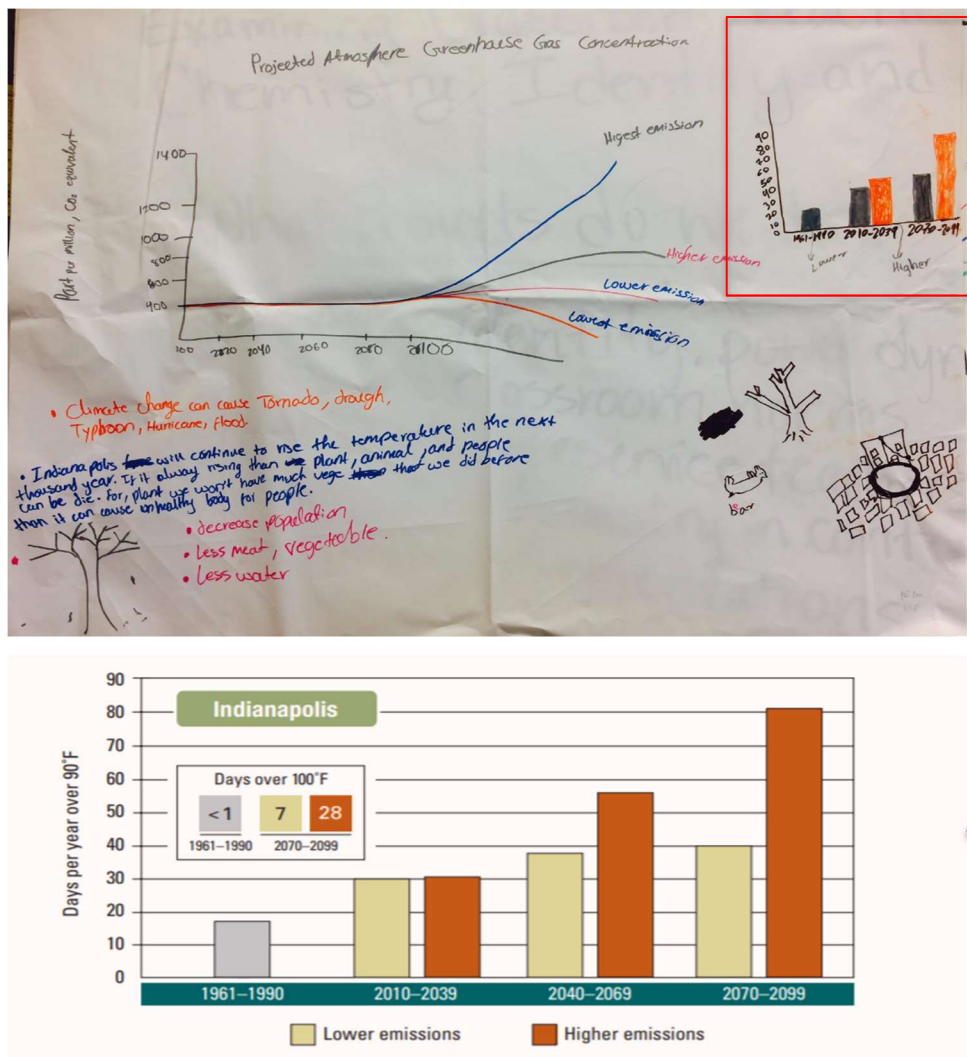


Figure 6.3. a) Poster created by Efraim and Nwe and b) Original graph where the drawing on the upper right-hand corner was based on.

Photo credit:

https://ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/climate-change-indiana.pdf

A quick search of the internet led us to a graph published in an article written by the Union of Concerned Scientists (2009), which we believe was the graph Efraim and Nwe were discussing. Although Efraim's explanation had incorrectly attributed the y-axis (number of days per year when the temperature is above 90 Fahrenheit) as temperature in his explanation, we argue that this was still a sophisticated display of his scientific understanding of the graph. He was able to infer a relationship between the y-axis and x-axis (time period) and attributed that such a correlation has dire consequences. His contribution was valued and thus was included in their final product. In

addition, the graph on the upper left side of the poster shows greenhouse gas emissions that MJR and Nwe were discussing. These two graphs are shown in conjunction with Nwe's writing about climate change in the lower left-hand corner. On the lower right-hand corner, Efraim has drawn a bear on its back, a dried up well, and a withered tree. These drawings were negotiated with Nwe as a way for him to contribute a drawing in lieu of writing on the poster as Efraim said he was not good at writing. This is a sophisticated and contextualized representation of his understanding of the effects of climate change. The overturned, dead bear implied animals dying; the withered tree signified the death of plants, and drought was represented as a well with dried ground which he describes as **“the water holes back in Myanmar a long time ago”** (English translation).

The shifting use of modes shows complexity in the ways that learners participated in the learning task. Efraim's adjusting the workspace to allow for access to the web resource he found reorients their group configuration by providing a focus for discussion. They collaboratively made sense of the graphical representation and Efraim made use of his L1 to explain the graph. Their interpretative work was then renegotiated into a multimodal representation in which combined on graphs, written words, and illustrations (Bezemer & Kress, 2015). This example shows the sophisticated ways learners made use of multimodality to support and foster one another's learning.

6.9 Discussion

This study explored the ways multilingual learners supported one another's science learning and engagement by looking at the interactions among dyads of learners with different home languages and degree of comfort in using English. We have found that learners exert efforts to establish status (Cohen, 1994) – usually in terms of academic status and/or English language proficiency- as it shapes the interaction of the dyads. Status within the dyads appear to be highly influenced by the language use determined by the setting and the situation.

Learners established status by engaging in social conversations to get to know one another. They explored commonalities in age, grade levels, hobbies, mutual friends, and experiences as possible ways they may “become friends”. Since we worked with resettled refugee youth, they talked about their migration experiences and schooling experiences. This was especially true for groups where one of the learners still attended EL classes (such as Jon and Apple and Efraim and Nwe). They talked about their struggles of being displaced from their home countries and the

challenges they met adjusting to their new home. Difficulties in learning English came out a lot in their conversations.

The perception that there is an expectation of English as the language of display in the afterschool program had various consequences in the youths' interactions. Though we deliberately did not impose an English only environment and encouraged them to use languages they were most comfortable in, English proficiency still mediated learners' access to learning tasks. Participants needed to communicate with facilitators and understand instructions given in English. They also had to read texts and activity handouts written in English. When doing online research, they used English keywords that led them to webpages in English. Thus, their English proficiency influenced their participation expectations – that is, what roles they played in the group tasks (e.g., the most English proficient participant usually is tasked as the speaker of the group) and what artifacts they are freely able to access (e.g., laptops usually are given to the most English proficient participant).

However, English proficiency did not hinder youth's collaboration in this particular population. Given their nature of wanting to help peers (Ryu & Tuvilla, 2018) and possibly having similar schooling experiences where their ideas are delegitimized due to their difficulty in expressing their ideas in English, the youth constantly positioned one another as co-constructors of knowledge and having legitimate ideas. They did so by constantly soliciting each other's ideas. We acknowledge that this may be due in part to the ill-natured structure of the task wherein “correct answers” were not easily found. Because the youth were tasked to make predictions about what climate change would be like in their chosen cities, the youth had a lot of freedom to do as they see fit and present and value their ideas in creative ways. Two focal dyads (Jon and Apple, Efraim and Nwe) kept asking the facilitators whether “there is no right or wrong answer” and whether the task is asking for their “opinion”. This is an affordance of the afterschool setting that we argue is crucial for developing youth's scientific thinking without the pressure of grades.

Social conversations at times served as a bridge towards greater science engagement. We shared one example in depth where Jon and Apple used Google Maps to search for their hometown when they were doing research to compare Malaysia and Indonesia. We argue that off-topic conversations may play a fruitful function for learners to establish ownership of the task and agentively decide the direction they accomplish the task. Learners bring a wealth of knowledge and providing space for learners to explore their own ways of thinking must be encouraged.

In any collaborative effort, disagreements are expected. The youth appealed to the authority of the facilitators to persuade their partners of their emerging ideas. However, the most successful groups in terms of forwarding each other's science learning were the ones who pushed each other's thinking and solicited one another for evidences and counter-arguments. We saw how Thiri and Da Zin fostered an environment where they were able to push one another to clarify their ideas. They were open enough to change their minds and take into account their partner's feedback. Lin Bo and Nyein engaged in productive disagreement and pushed each other to provide evidence to try and persuade the other. In terms of scientific practices, they were "asking questions and defining problems, analyzing and interpreting data, using mathematical and computational thinking, and engaging in argument from evidence" (NSTA, 2009).

6.9.1 Affordances of translanguaging and multimodality in Project RESET

In three of the focal dyads (Jon and Apple, Thiri and Da Zin, Efraim and Nwe) we found examples where youth translanguaged in their interactions. The different dyads flexibly moved between languages for specific purposes. In Jon and Apple's case, what was most striking was how they were able to communicate despite not speaking a common language. It is important to mention that Jon attempted to use Apple's language which we argue not only displays his grasp of different Burmese ethnic languages but also showed his willingness to communicate openly with Apple. Apple's attempt to use her home language more showed her attempt to ensure that Jon participated in the idea generation as well as poster making. In the moments Apple switched to English, she used phrases that were more accessible for Jon. In attempting to explain "flood" she did not deem Jon lacking in understanding of what flood means despite not knowing the term. We see how Apple consistently positioned Jon as an able contributor to the task – and in turn, Jon found many ways of contributing to their group output. During their search for their hometown we saw how Jon had a lot of knowledge about Myanmar's geography and when they were predicting outcomes for climate change in Malaysia, Jon also had a lot of ideas he shared. In their final output, given their perception that the language of their product must be in English, Apple did the bulk of the writing. Yet we also see Jon's drawings of the graph and illustrations of the world. This is evidence of Jon's science engagement.

We observed the same in Efraim and Nwe's case wherein their interactions were mostly in their respective home languages. Efraim's contribution to the sense making were substantial to the dyad's understanding of climate change in Indianapolis. He found the webpage which had important information about gas emissions. Despite the initial confusion as to what the graph meant, Efraim was able to decode the meaning of the graph and eventually found a way to explain to Nwe. Here we find evidence that Efraim may have limited ways to articulate his ideas in English yet his grasp of the scientific phenomena was immense. We see it time and again in these cases that English proficiency does not determine the depth of scientific understanding.

In Thiri and Da Zin's case, their flexible use of Hakha and English has allowed them to explore their ideas without the restriction of speaking only in English. We argue that translanguaging is empowering in such that their home language gives them access to scientific sense making and does away with the notion that science can only be learned through the English language.

In addition to translanguaging, multimodal ways beyond language not only affords learners new ways of sense making but also ways to display their knowledge. We demonstrated how Jon was able to showcase his knowledge of geography and contributed to their group task. We saw how Efraim decoded the meaning of a graph and explained it to Nwe. We also saw how Lin Bo and Nyein used the graph to engage in productive disagreement. Efraim and Jon contributed to their respective posters by creating graphs and pictures to signify their understanding of climate change. These are evidences that multimodality are not merely scaffolds for ELs but authentic ways of showcasing their knowledge. By being able to contribute in their group tasks, they expand the ways they participate and reposition themselves as able contributors and not merely as learners that require help. We argue that multimodal ways empower the youth in their science engagement and learning.

6.10 Conclusions

There are about 7000 languages spoken globally (Lewis, 2009) yet only a handful of them are used as language of instruction (Walter & Benson, 2012). Despite the worldwide shift towards a multilingual reality, schools remain staunch on monolingual language practices complicit with the dominant power structure (Bourdieu, 1991). Multilingual learners continue to be educated in the dominant language without leveraging their home language practices (Garcia & Wei, 2014).

In the field of science, the dominance of English is well documented. (Ammon, 2001) Most tertiary levels of education is taught only in English such as in the case of Israel, Philippines , Austria, and Switzerland (Carli & Ammon, 2007). This is problematic when we consider that most science classes are already taught in ways that do not provide learners opportunities to engage in dialogic argumentation (Driver, Newton, & Osborne, 2000; Lemke, 1990; Mortimer & Scott, 2003; Pimentel & McNeill, 2013). Monologic forms of classroom discourse via Initiation-Response-Evaluation (IRE) pattern (Cazden, 1988; Sinclair & Coulthard, 1975) are still the prevailing frames of instruction in science classrooms (Christodoulou & Osborne, 2014). When compounded with the conflation of English proficiency to scientific acumen, learners are shortchanged in their scientific sensemaking.

What disadvantages are there when learners are not allowed to use their language? There is a reinforcement of the belief that their home language does not give them access to scientific sense making as well as a belief that only through learning English can one learn science. This is certainly not true, otherwise countries such as Finland, Norway, China and Japan who teach science in their own languages would be lagging behind now (Carli & Ammon, 2007). Moreover, having a pre-requisite of English proficiency to learning science distances the lay person from science. It is a way that knowledge distribution becomes inequitable in such that only the elite few who can afford English language lessons can gain access to science knowledge. We also see how this tracking of ELLs have disqualified learners from getting quality science education and better opportunities such as in the case of learners who are barred from taking AP Classes (Kanno & Kangas, 2014; Callahan, 2018).

Logistically, we are not campaigning that English language be done away with, but that learners be allowed to practice complex language and multimodal practices and not be hindered with English use. Learners have taught us time and time again that they know more. As educators, the onus is on us to understand exactly what learners bring to the table and not make assumptions on what they know and do not know. We do our learners a great disservice by setting low expectations in their science content knowledge because *we* are unable to access what they know.

Science in our view is a way of thinking and is not articulated on one language alone. Historically, science was communicated in multiple languages and only due to the rise of the United States as a super power has English become an unofficial lingua franca of science due to the monopoly of English texts. This does not bode well for diverse ways of thinking. We are

limiting ourselves from harnessing our full scientific capability if we do nothing to break these imposed language barriers.

On a final note, our views on how learners can be empowered by translanguaging and multimodality echoes that of Alim's (2005) conception of critical language awareness. Critical Language Awareness "views educational institutions as designed to teach citizens about the current sociolinguistic order of things, without challenging that order, which is based largely on the ideology of the dominating group and their desire to maintain social control. This view of education interrogates the dominating discourse on language and literacy and foregrounds... the examination and interconnectedness of identities, ideologies, histories..., and the hierarchical nature of power relations between groups" (p.28). In equipping learners an awareness of their communicative behaviors, they can channel their abilities in ways that can transform their conditions. We find that despite our efforts in valuing youths' diverse language and multimodal practices, youth would still conceive their lack of English proficiency as a deficiency in their science engagement despite evidence that suggests they are able to engage in science successfully in their own languages. We find that this is a reflection of the messages of "discrimination", "racism" and "stereotyping" that youth encounter in the society. Thus, if we are to foster empowerment in our learners, we must confront the "harsh ways of the world we live in" (Sledd, 1996, p. xx). We need to rethink our pedagogy and teach not just our marginalized learners but learners of the dominant society as well that different ways of doing does not mean deficient. We can encourage translanguaging and multimodal practices in our learning settings in such that it becomes a norm. We need to inculcate in our learners the notion that English proficiency should not be the factor that determines one's science learning and engagement. Rather, one should draw on their multiple competencies and multimodal ways to successfully navigate their science learning and engagement.

6.10.1 Practitioner/Research implications

In this paper, we explored the ways multilingual youth engaged in collaborative science practices and supported one another's science learning and participation by drawing on their rich linguistic and communicative resources. We found that through strategic use of multiple languages and communicative modes beyond the spoken word they were able to leverage their sense-making practices. In doing so, they further their own and their peer's understandings by making it possible

to forward ideas that they would have otherwise not been able to share because of their perceived limited English proficiency. Because learners' ideas are listened to, considered, and valued, this creates a more equitable learning environment. We recognize that linguistic borders in schools keep ELs from participating in science learning. In science where vocabulary and discourse are so important, limited English proficiency can make it challenging for teachers to recognize the depth of EL's understanding making it difficult to build on what students already know. But by encouraging multilingual collaborations in open-ended tasks, students may value the knowledge of their peers in ways teachers may not be able to and offer a supportive environment for science learning.

CHAPTER 7. CONCLUDING REFLECTIONS

This dissertation has investigated minoritized learners' science engagement in an afterschool program through multimodal interaction analysis. Specifically, I sought to answer two research questions: 1) *'How do multilingual learners use multimodality in their science engagement?'* and 2) *'How does the use of multimodality afford productive science engagement?'*. In this chapter I revisit these two research questions and pinpoint the findings that emerged as a result of the preceding analysis of the corpus of data. In addition, I reflect and conclude on the conceptual, analytical, and methodological contributions of this study. Specifically, I highlight the contributions of this study and consider its general relevance and point out implications of my work on the dimensions of teaching and research. Finally, I present some areas yet to explore and suggest recommendations for relevant future research.

7.1 Revisiting the research questions

7.1.1 How do multilingual learners use multimodality in their science engagement?

Analysis of the corpus of data showed that learners used multimodality to achieve their science learning goals. In the afterschool context, learners' goals are of two themes: 1) to participate in the afterschool program equitably by sharing opportunities for learning and 2) to pursue science ideas for their own and others' learning. In this work I broadly operationalized learners' science engagement as the activities that learners engaged in that led towards their increased participation in the emerging norms of the afterschool program (Lave & Wenger, 1991). To accomplish learners' goals, they used multimodality in their science engagement. First, learners used multimodality to negotiate equitable participation. Second, learners used an ensemble of modalities in their co-construction of knowledge.

In this work, I viewed participation as the negotiation of group membership, roles, and cognitive authority. Preceding analysis demonstrated that these various aspects of their participation were negotiated through strategic use of modes. In the analysis, I recognized that learners' goals at times worked towards or against group goals. The nuance seems to lie in terms of whether they valued group goals (e.g., achieving the objective of the activity they are engaged

in in a coordinated and equitable manner) or their individual goals (e.g., contributing meaningfully towards the achievement of the goal) in the moment-to-moment. Actions that worked in congruence with group and individual goals were encouraged within the groups while actions that caused disagreements between group members were negotiated further.

In terms of specific function of modes in learners' negotiations of participation, several themes stood out in the analysis. First, proxemics gave insights into group membership, internal dynamics, and the kinds of collaborations that ensued in small groups. While the general layout of the setting plays an important influence in how learners arrange themselves, learners also configure themselves that indicate their comfort level working with a group. Second, material artifacts played a role in how learners chose their roles in group tasks. Material artifacts bring to bear a status in which some material artifacts are more desirable than others. I argue that learners place value on material artifacts by virtue of how the material helps learners achieve their goals. In general, learners appear to prefer materials that provide learners access to information or provide permanence to their contributions as dictated by the learning goals of the task. Additionally, learners' access to material artifacts and thus, their choice of role is also dictated by learners' status. Therefore, when learners have high status, learners appear to have more access to their preferred material artifacts. Finally, learners used an ensemble of modes to negotiate cognitive authority. Learners used gestures, material artifacts, images, along with utterances to express agreement/disagreement and persuade one another when there are differing ideas. While utterances were key in the negotiations of cognitive authority, there were multiple instances where negotiations were only through other modes that did not include utterances. Thus, in this sense, multimodality should not be overlooked in these negotiations of participation.

7.1.2 How does the use of multimodality afford productive science engagement?

In this work, I used Engle and Conant's (2002) framework for productive science engagement. In my analysis, I found that the use of multimodality was distributed in the co-construction of knowledge. By distributed, I refer to the ways learners coordinated with one another using an ensemble of modes in their generation of knowledge. This is reasonable to argue as Roberts and Rogoff (2012) also found the same in their work where they saw how Mexican-heritage children used their "hands and eyes" to help one another. The argument I add to this

conversation is to point out that the embodied mode may not necessarily be manifested by one individual alone; rather co-construction can also occur as an ensemble of different modes as performed by multiple learners. In this case, the co-construction of knowledge occurs in multiple modes by multiple learners.

In fostering one another's science engagement and learning, multilingual learners negotiated language expectations through translanguaging. Their flexible use of all communicative modes – all languages in their repertoire as well as the different modes – provided learners the freedom to contribute without being limited to articulate their ideas in English alone. These language negotiations structured succeeding interactions since negotiation of language expectations appear to also be negotiations of learner status. These negotiations set the precedence for the kinds of contributions learners are able to make and their limitations in contributing to the task.

Learners engaged in social discussions that promoted productive interactions and science thinking. Social discussion that may include off-task talk may be opportunities for learners to bring in topics that they already know. Learners draw on topics that may not be directly related but are more relatable and thus more accessible to them. Through exploration of these relatable topics, these off-task conversations are generative in learner scientific sensemaking.

In their interactions, learners forwarded one another's learning by being open to discussion and being flexible to allow space for each other's ideas. Disagreements occurred but these were opportunities to engage in furthering their learning.

Finally, learners used multimodality to contribute beyond language. When tasks required participation using the English language, learners sought ways to contribute beyond language alone. Moreover, learners who were more English proficient also provided peers opportunities to do so by encouraging them to use translanguaging and multimodality. For example, learners encouraged one another to use images, explain challenging English concepts using gestures, images, and or through translanguaging. I make a special note here that translanguaging is a strategy used by multilinguals depending on their task and interactors. It is not merely an act of codeswitching where they use different named languages in an utterance. Rather, it is a strategic action to accomplish multilingual learners' emerging goals.

7.2 Contributions of the study

7.2.1 Conceptual contribution

Attention to multimodality affords the ability to reimagine the possibilities of how we define science engagement. By providing opportunities to exercise multimodality, we broaden how we perceive learners' science engagement. In this way, multimodality allows learners to negotiate their status in learning settings and reposition themselves in more empowering ways. This work has demonstrated that learners actively participate in ways beyond language alone. I provided multiple examples of multimodal evidences of learners' science engagement.

7.2.2 Contributions to Research

Despite the context-specificity of this study, I argue that several issues are of general relevance to other stakeholders outside of the specific context. First, this work of applying multimodal interactional analysis represent a method that is applicable in other learning settings beyond the afterschool. Carrying out such a research in superdiverse formal classroom settings would be relevant, interesting and would corroborate the findings of this dissertation. Second, while the interactions analyzed in this work are both participant- and context-specific, this work has provided guidelines on the basic negotiations of participation that are likely to occur in any learning setting.

This work is innovative in its use of multimodal transcription and creation of multilayered videos. Through this work, I demonstrated that the flexible use of transcription formats affords the ability to analyze modes with a variety of analytical foci. By highlighting which modes are salient in the moment, a flexible transcription format can give us a snapshot of which of the mode is foregrounded at the moment. The creation and use of multilayered videos afford the ability to capture all the various data sources available for analysis. Not only does this allow a holistic view of the data, this also provides a means to reconstruct the moment as close to the original form that was captured on video.

Using ethnographic techniques yet also innovating by drawing from multiple frameworks (e.g. semiotics, video analysis, discourse analysis, interactional analysis etc.) has afforded a way to examine moments in various time scales. While majority of the analysis in this dissertation were in minute timescales, I recognized the influence of the bigger time scales in those moments as I

did my analysis. Ethnography has allowed me to grapple with the complexity of overlapping timescales.

7.2.3 Contributions to Afterschool Learning Settings

In this work I provided detailed descriptions in how the afterschool program was implemented. In the appendix, I also provide the curriculum that was used for RESET. Future researchers can utilize the curriculum as a starting material. What I consider innovative in this curriculum is the provision of “real prompts” that encouraged learners to draw on their multiple competencies and their funds of knowledge. Real prompts are prompts that do not have a right or wrong answer but rather gave learners opportunities to find creative solutions and explore a topic further. Moreover, these prompts were provided by extensions of the community requiring real answers (e.g., Ines asking for practical advice for her trip to Malaysia).

Another innovation of this curriculum is the addition of prompts that sought to explore the unique perspectives of transnationals. Since the youth I worked with are resettled refugee youth who have lived in multiple places, their migration experiences became important knowledge resources which the youth brought to the setting.

7.2.4 Contributions to Teaching

While interactions are complex and highly influenced by contexts, I find multiple ways that educators might apply the findings of this study. In general, teachers can pay more attention towards the interaction patterns in their classrooms and therefore apply the insights gleaned here as a resource in their teaching. For example, proxemics structured a lot of learners’ interactions and access towards material resources. In addition, learners negotiated roles by their access to material artifacts. Therefore, attention to the materiality of teaching/learning moments – whether through the modes of layout and/or the role of material artifacts in interaction - gives us important insights as to how we may structure classrooms and activities. In several cases, the material artifacts gave insights as to learners’ preference of roles. Moving forward, teachers can ensure that the material artifacts are in synchrony with what we expect learners to accomplish. For example, if we expect learners to demonstrate their thought process in their learning, we can structure the materials to allow learners the freedom to do so. Perhaps post-its would be better for learners to

work with uncertainty and change their ideas compared to strictly formatted answer sheets. Perhaps a less structured arrangement of desks and chairs would allow freer movement if we want to encourage groupwork.

I close this section with a quote from Quinslisk (2008) that highlights the importance of multimodality in our teaching:

“If we want to create an environment in which students are comfortable enough to take risks, use a new language, and access the target language community, then we must pay attention to the communication strategies we employ. For example, do we think about what we are doing nonverbally while students are engaged in group activities? Do our nonverbal actions reinforce or contradict our verbal directions? [...] Most importantly, do we view nonverbal communication as an integral part of the communication processes that we simultaneously teach and model for our students?” (p.39)

Whereas it is a given in science education to use multimodal ways in our teaching through our use of images, apparatus, models, etc; we need to ask ourselves if we also encourage our learners to display their learning in multimodal ways or do we restrict their demonstration of science engagement only through their English articulation.

7.3 Recommendations for future work

Not included in this dissertation is a manuscript on how RESET provided material, ideational, and relational resources that fostered youths’ productive engagement. That work is still currently in progress. However, in this section, I highlight the issues that were not pursued in this dissertation as well as propose future work worthy of exploration.

First, although the theme of the afterschool program was on climate change, this dissertation has not paid much attention to resettled refugee youths’ perspectives on climate change. Given the urgency of the climate change issues we are facing in the present²⁰, understanding the youths’ transnational perspectives would be valuable. Moreover, with the worsening effects of climate disasters, more and more people are displaced (UNHCR, 2020). The United Nations High Commissioner for Refugees [UNHCR] reports that cross border movements have been greatly influenced by adverse effects of climate change interacting with conflict or violence. However,

²⁰ I write this with the devastating Australian bushfires of January 2020 in mind.

“climate refugee” does not yet exist in international law and is not yet endorsed by the UNHCR. This has created a complex situation on the implementation of refugee law. Since the UNHCR projects an expansion on the refugee criteria of the 1951 Convention relating to the Status of Refugees, it may be valuable to look into resettled refugee youths’ perspectives on the interaction of climate change effects into their resettlement.

Second, from the rich corpus of data collected, a data source that was mostly left untouched were the youth-generated artifacts (e.g., video logs, essays, posters, final presentation videos etc.). With the numerous visuals from these artifacts, a study on visual narrative would be interesting. Visual narratives describe how individuals produce and comprehend sequential images (Cohn, 2016). Employing multimodal analysis in the analysis of the drawings and/or videos can give rich insights into youths’ perspectives on what they are learning.

Finally, as suggested earlier, a logical next step is to apply multimodal interactional analysis in a formal classroom setting. An initial study can inquire on how learners use multimodality in their classroom engagement. In the next iteration, modifications to the curriculum can be implemented to leverage multimodality and a second study can be done on whether there are improvements or not in the individual and collective engagement of the learners. An extension of the work can be on creating educative curriculum materials (Davis & Krajcik, 2005) that can incorporate teacher learning on how to successfully integrate multimodal practices in lessons. The possibilities are endless.

7.4 Concluding thoughts

I started this work with a proposition that as educators we need to find ways to address the challenges arising from globalization and migration movements – even that of superdiversity. As I write the final pieces of this dissertation, we are in the midst of a global crisis of climate change and the ongoing refugee crisis. Never have we lived in such challenging times. What I sought to contribute in this dissertation serves as the first step in my life’s mission of improving educational conditions for learners – especially, minoritized learners. It is my hope that this dissertation would have provided insights to researchers and educators in furthering work towards science for all.

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APPENDIX A

Weather and Our Life

LESSON 1: LET'S SHARE OUR EXPERIENCES OF WEATHER!

GOALS OF THE LESSON

Start to think about weather

How do we describe the weather (through words, non-verbal performance, and weather forecast)

Why is knowing about weather important?

MATERIALS

Folder with name tag, RESET Website introduction cards, markers

BINGO sheet for the icebreaker

Facilitator's computer and projector

Various weather pictures

Weather forecast videos

Lined Sheet for essay writing

ACTIVITIES OF THE LESSON

All participants introduce themselves to each other by sharing their name and what kind of weather they like.

ACTIVITY 1: ICEBREAKER – CONNECTING TO WEATHER AND/OR PRACTICING SOME ENGLISH PHRASES (ABOUT 15 MINUTES)

The students are given a BINGO sheet. They will be instructed to meet other students and collect the names of those who fit the description on the sheet. The student who has the most number of students' names and ticks off the most number of categories wins.

Everyone will introduce themselves and state their favorite weather.

The folders will be handed out. Students will be asked to wear name badges for the remainder of the lesson. They will be asked to save their name badges to be used to label their folders which will hold their activities for the rest of the year.

ACTIVITY 2: INTRODUCTION TO THE BIG PICTURE OF THE YEAR (ABOUT 5 MINUTES)

The instructors introduce few big picture questions for the year

How does weather impact us?

How do we impact weather?

What is climate change and how does it impact our life?

What should we do about what we know?

The RESET website will also be introduced.

ACTIVITY 3: HOW TO EXPRESS WEATHER PHENOMENA? (ABOUT 20 MINUTES)

Group activity and whole class acting out weather scenes

Form a group.

Each group will receive the exact same set of weather pictures, of which one picture is marked.

Students talk about the weather picture that they get within their group (groups of 3 or 4).

Each group then act out non-verbally to describe the picture that is marked. Each group non-verbally expresses one picture from the collection. Other groups figure out which one they are expressing and describe them linguistically.

ACTIVITY 4: WHY IT IS IMPORTANT TO KNOW ABOUT WEATHER IN ADVANCE? (ABOUT 20 MINUTES)

Group activity and whole class sharing

There are other people who are also very much interested in weather and talk about it everyday. who are they? Hint: they come on TV news, they predict the weather, and inform people about what the weather is going to be like. : weather forecaster

Let's watch weather forecast from three different countries. While you watch, focus on two things:

how they express weather? (e.g., language, clothes, setting, weather scene, map, etc.)

what about weather do they talk about?

After watching the videos, talk about the two questions.

Who would need to know about weather beforehand and why?

Prompts for group discussion: "do you check the weather of a day every morning? what do you want to know about weather? Why?" "Imagine you are a runner." "Imagine you are a farmer," etc. Help them identify specific life situations in which weather forecasting is particularly important.

ACTIVITY 5: WRITING AN ESSAY.

Possible topics

Why is weather forecast important?

There is a person who argues that there is no need for weather forecast. The person says, "it is such a waste of money and resource. People will know the weather when it comes. There is nothing we can do even if we know that it is going to rain or snow. We cannot stop them." What would you say to the person about the importance of weather forecast?

FACILITATORS' NOTE

Activity 3 was modified because several students left early. Instead of the charades where groups were supposed to act out the weather phenomena, the students spent a lot of time talking about the weather pictures and associating weather phenomena with different places. The weather images could serve as a catalyst for conversation so interesting pictures may be worth choosing in the future

BINGO SHEET FOR THE ICEBREAKER

The objective of this game is to meet as many people as possible! If they fit the description in the boxes below, have them sign their name on your BINGO sheet. Have fun!

B	I	N	G	O
Went to another state (outside of Indiana) for the summer	Has NO Facebook account	Has more than 3 siblings	Wears glasses	Can whistle
Has a first name that starts with either A, B, or D	Is wearing something red	Has a first name that has at least 3 syllables	Wears earrings	Can sing and dance
Was born in August	Ate chicken today	FREE SPACE	Loves video games	Is scared of spiders
Plays guitar	Brought their backpack	Has an older brother	Writes with their left hand	Does not know how to swim
Plays Pokemon Go	Is wearing shorts	Has a mole on their arms	Is the oldest child in the family	Has watched a movie in the past week

WEATHER PICTURES

250











WEATHER FORECASTS VIDEOS

Indiana: (August 26, 2016)

<https://weather.com/news/news/tornado-outbreak-midwest-indiana-ohio>

UK (August 26, 2016)

<http://www.bbc.com/weather/forecast-video/21416743>

Philippines (August 16, 2016) – 2:28 min – 3:50 min

<https://www.youtube.com/watch?v=hmclm4zuGSs>

Louisiana (Aug 12, 2016)

<https://weather.com/storms/severe/video/louisiana-rainflooding-could-spread-to-ohio-valley>

Philippines (June 9, 2015) (1:37 min long) (rain, earthquake)

<https://www.youtube.com/watch?v=C2NhqXghT0k>

Myanmar (July 30, 2014) (3:48 min long)

https://www.youtube.com/watch?v=BPU_1M0UJnM

Korea (February 6, 2014) (1:25 min long)

<https://www.youtube.com/watch?v=CBQnbsoQZ5w>

Indianapolis (August 16, 2016) (0:33 seconds) --Tornado

<https://www.youtube.com/watch?v=hiNPkpa6BGw>

LESSON 2: LET'S DEFINE WEATHER VARIABLES

GOALS OF THE LESSON

Define weather phenomena and variables

What are variables of weather?

What do we want to talk about when we say weather?

Would the aspects of weather be different in different geographic locations?

Compare different and similar weather phenomena in different parts of the world, Burma and the U.S.

MATERIALS

Reading Material on Weather Variables

Computers for posting the blog

Water bucket

*PETE drink bottles (see Facilitators' notes)

Post it notes

ACTIVITIES OF THE LESSON

Review what we did last week and share a few essays that they have written.

ACTIVITY 1: LAB: CAN YOU FILL UP THIS BOTTLE? (ABOUT 20 MINUTES)

Group activity and whole class sharing

Ask students if they can fill the half cut drink bottle with water all the way up. Then, as a group, they will try to fill it up. If there are groups that are able to make it work, have them show the other groups how to do it. Ask them why the water doesn't come down. Then, ask them how to make the water come down.

ACTIVITY 2: READING ABOUT WEATHER AND WEATHER VARIABLES (READING: ABOUT 25 MINUTES; CLASS SHARING: ABOUT 15 MINUTES)

Group activity and whole class sharing

Last week, we talked about "what about weather" we want to know everyday, such as temperature, rain, snow, etc. These are referred as "weather variables." – this is a breakdown of "weather" and specifics of weather characteristics. This is a way to communicate with people about weather. For instance, even if someone says that it is hot, another person may not feel it is hot. The person may come from a hot region in the world, so she is used to hot weather. Or just

simply they have different sense of feeling. So better communicate about weather phenomena, we can say what the temperature is. So this is weather variable. Instead of the weather is hot today, you can say, “the temperature of today is 80 degree, so it will be hot.”

In a group of three (or four), students will read about weather and weather variables. The students will accomplish the talking points/activities within the group. One of the discussion questions asks the students to compare the weather in Chin State (or a place they have lived in) to the weather in Indiana. The idea is to foreground the writing of the essay in Activity 3.

As a whole class, share what each group has. Discuss how students understand the weather variables and if there are other weather variables they have come up with. Clarify ideas that are unclear about the reading. Explore questions that came up during the discussion.

Ground rule for reading:

The goal is to understand the meaning of the text, not simply read it through. If any idea in the text does not make sense, stop and discuss.

Another important goal is that everyone understand the reading material. Make sure everyone is on the same page. Stop and check each other’s understanding occasionally.

There might be some parts that do not make sense to everyone in the group. Mark those parts and talk about them when we discuss as a whole group.

As you read the text, you may come up with new, related questions, which is great. Jot down those questions so that you can share your questions with other people and pursue answers to those questions.

Groups that have completed reading discussion can start working on the essay by developing an outline.

ACTIVITY 3: TELL YOUR WEATHER STORY WITH THE WEATHER VARIABLES THAT WE IDENTIFIED. (ABOUT 15 MINUTES)

Individual

Now that students know more about weather variables , they will be writing a short essay (one-half to one page long) for a newsletter. Your essay is to explain how the weather is like in Burma and/or any other region in which you used to live and how your experience of weather was like when you first moved to Indiana. Readers of this newsletter are primarily people who were born and have lived only in Indiana.

Students will be given time to enter their stories into the blog. They will be encouraged to add images to their blog post. If they have not finished they can complete it at home.

ACTIVITY 4: WRAP-UP: REMAINING QUESTIONS AND INTRODUCTION OF THE GALILEO THERMOMETER

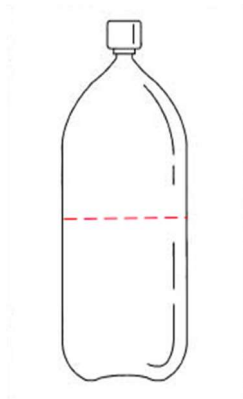
Are there still some terms/weather variables that you do not understand? Let's keep those in our "bag of words."

We can keep a large chart paper with Post-it stick on the paper. (or a box with post papers)

FACILITATORS NOTE

The students were only able to do up to the first page of the reading material.

The soda bottles must be cut carefully and tested out prior to giving to students. The bottle is cut half-way in the middle. The bottle must remain capped. Test by filling it with water. The pressure should hold the water in.



READING ON WEATHER VARIABLES

What is weather? What do we mean when we say “weather”? In this reading, we will learn about different aspects of weather.

What was the weather today like? How would you describe it? Was it sunny, rainy, or cloudy? Think of 5 more adjectives to describe weather and draw a symbol/picture that you associate with the words you came up with.

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In the box below, sketch what a typical weather is like in Chin State (or anywhere you used to live) and Indianapolis. You need to pick a month that you want to compare. Then, sketch what is it like in that month.

Your choice of month: _____

<p>_____</p>	<p>Indianapolis</p>
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Weather is the condition of the atmosphere at a given time with respect to 1) heat, 2) pressure, 3) motion, and 4) moisture. When you drew your picture about weather, what components of these four

did you consider? Circle and label in your drawing things that indicate heat, pressure, moisture, and motion.

Now, we will learn how to express and describe weather phenomena using words and numbers with respect to the four components. What might be some benefits of words and numbers over pictures and symbols we used in the previous page? Any disadvantage? Talk about it in your group for a minute and write in the blank space below.

Heat

Heat is the transfer of thermal energy. Temperature is a quantitative measure of how hot or cold the weather is. If someone says “it’s hot,” what temperature does it mean? Is 70F hot or cold? How about 30F or 110F?

How can temperature help us communicate about how hot or cold a day is?

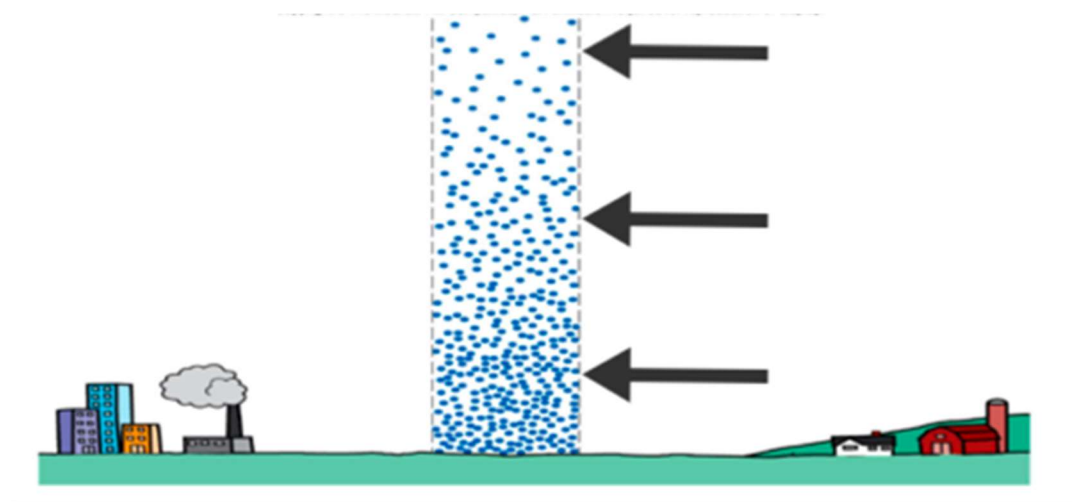
Temperature can be measured in Celsius, Fahrenheit, or Kelvin. What unit is used in Burma and the United States?

Pressure

Air pressure or atmospheric pressure is the force of air pushing down on Earth. Air pushes itself and exerts force in all direction, including downward on the Earth. You have probably heard of pressure before. In Physics, we define it as a force exerted over an area. Because of gravity, air (more specifically, air molecules) has weight. The force of air molecules exerted on a certain surface area due to their weight is air pressure. In the space below, draw what air molecules look like in an area of high air pressure and low air pressure.

High air pressure	Low air pressure

The picture below shows how the number of air particles change depending on altitude. From what you know now about air pressure, label the arrow to indicate which area would have higher pressure and lower pressure. Explain why. How are density (how tightly packed molecules are) of air molecules and air pressure related? From your answer to this question, what can you conclude about the relation between air pressure and altitude?



Unlike other weather variables, such as temperature, wind, and precipitation, we do not much experience and feel the differences in air pressure. But air pressure is very important. Why do you think it is important? Brainstorm some ideas.

Motion

Wind is the movement of air. Here, we would like to explore what causes wind and how to predict the direction of wind. First, we can start with the idea that *wind is caused by horizontal differences in the atmospheric pressure*. More specifically, when there is a difference in air pressure, air moves from a location of higher pressure to a location of lower pressure. Why? Come up with some ideas.

If we understand that the air moves from higher pressure to lower pressure, the next question would be “what makes higher air pressure and lower air pressure in different parts of the earth’s surface?” One answer is an uneven heating and cooling of the surface. That is, although the Sun shines on the Earth the entire Earth, the Earth does not become heated at the same rate. As a result, some parts of the surface become hotter than other parts. What would make this uneven heating? Come up with two or three scenarios in which the Earth’s surface is heated differently.

Based on your understanding of wind, think about this question: If the wind blows strongly, what does it indicate about air pressure around the area?

Moisture

Moisture means water diffused in other substances. When talking about weather, we are interested in water diffused in the air and other weather phenomena involving water. Humidity, dew point, cloud type and cover, and precipitation, are components of the weather related to moisture in the air.

Humidity refers to the amount of water vapor in the air. It indicates the likelihood of precipitation, dew or fog. When there is a lot of water vapor in the air, humidity is high. Can you think of places that would have high humidity? Low humidity?

What would be humidity like on a hot, muggy day? How about on a cold, dry day?

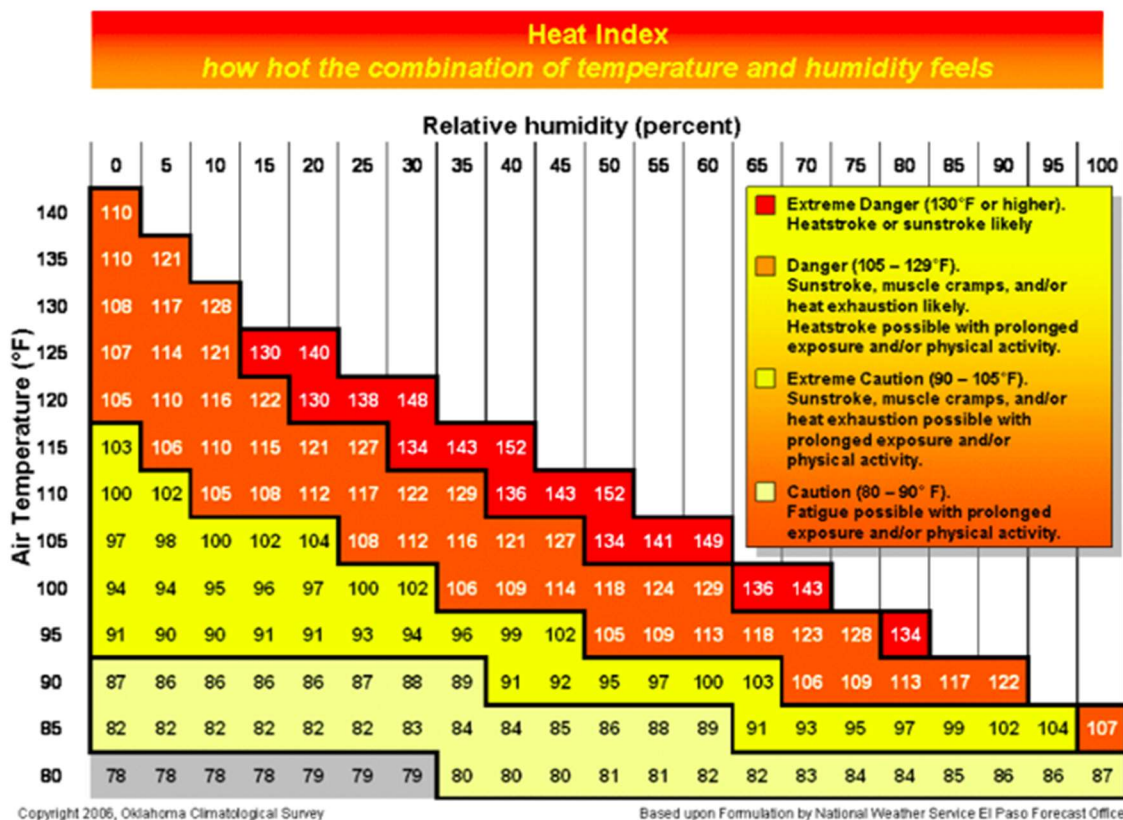
What would the humidity be like in a rainforest, places near the ocean, a desert, and in the North Pole? What makes you think so? Discuss this in your group.

Relative humidity is the amount of water vapor in the air compared with the maximum amount of water vapor that the air can hold at a certain temperature. It is a way to quantify humidity and expressed in percent. Humidity reported in weather forecast or any weather app is actually relative humidity.

Relative humidity is influenced by the temperature. It is because the amount of water vapor that air can hold differ at different temperatures. Which would hold more water vapor – warm air or cold air? How so?

A heat index combines air temperature and relative humidity as an attempt to determine human-perceived equivalent temperature, as how it would feel if the humidity were some other value. This is where we get the “feels like temperature” or “apparent temperature”. Below is the heat index. Check the current weather—current temperature and humidity. Using the table below, estimate the current heat index. Is the number the same as feels like temperature in your weather app?

Let’s investigate the data table more closely. What did you notice? Find three patterns/trends that you can find from the table of heat index. Use the space below to write/illustrate your ideas.



Dew point is the temperature at which water vapor condenses into liquid water.


Earlier, we discussed that warm air can hold more water vapor. If the temperature of a body of air drops, the air cannot hold as much water vapor as it would do at a higher temperature. If it keeps dropping, what would happen? The water vapor must come out of the air. In other words, water vapor condenses into liquid water. When it happens, dew forms. Dew point is the temperatures at which condensation begins.

You have probably seen dew form on the leaves of plants or cars. When is it more likely to happen? In particular seasons or times of a day? Why do you think so? You can use the space below to write/illustrate your ideas.

Dew point is related to humidity. If humidity is high, is dew point high or low? Why do you think so?

Cloud cover and type vary according to the amount of moisture in the air at different elevations. Clouds can provide a lot of information about air movement and moisture content. Basic weather predictions can be made using cloud observations. How many different types of clouds can you think of? In your group, discuss different type of clouds, sketch and describe them (e.g., shape, color, height, size, etc.).

Cloud cover refers to the fraction of the sky covered by clouds. It is measured in Oktas, or how many eights of the sky is covered. A sky that is completely covered in cloud is called overcast and has 8 oktas of clouds. Here are the symbols used in weather maps to signify cloud cover.



	Symbol		Symbol
Clear sky	○	5/8 covered	☉
covered 1/8 or less, but not zero	①	6/8 covered	☼
2/8 covered	☁	7/8 covered	☾
3/8 covered	☂	sky completely covered	●
4/8 covered	☎	sky obscured, e.g. by fog	⊗

In this picture, what do you think is the cloud cover?



Do cloud types and cloud cover affect how we experience weather? Talk about this in your groups.

Precipitation is any product of the condensation of atmospheric water vapor that falls to the earth. Precipitation can be liquid (drizzle, rain, fog condensation), freezing (freezing drizzle, freezing rain, rain and snow mixed or "snein", sun shower) or frozen (snow, snow grains, ice pellets or sleet, hail, snow pellets or graupel, ice crystals). *Images from <http://www.srh.noaa.gov/jetstream/global/precipitypes.html>*

Rain. Most commonly observed, drops larger than drizzle (0.02 inch / 0.5 mm or more) are considered rain. However, smaller drops are also considered raindrops if, in contrast to drizzle, they are widely separated.

Drizzle. Fairly uniform precipitation composed exclusively of fine drops very close together. Drizzle appears to float while following air currents, but unlike fog droplets, it falls to the ground. Quite often fog and drizzle occur together.



Ice Pellets (Sleet). Precipitation of transparent or translucent pellets of ice, which are round or irregular hard grains of ice consisting of frozen raindrops, or largely melted then refrozen snowflakes.



Hail. Precipitation in the form of small balls or other pieces of ice falling separately or frozen together in irregular lumps. Associated with thunderstorms, individual hail stones are ¼ inch (5 mm) or greater in diameter. Hail sizes of 1 inch (2.5 cm) or more are indicative of severe thunderstorms.



Small Hail (Snow Pellets). Precipitation of white, opaque grains of ice that are round or sometimes conical. Diameters are less than ¼ inch (5 mm).



Snow. Precipitation of snow crystals that are mostly branched and in the form of six-pointed stars.



Snow Grains. Precipitation of very small, white, and opaque grains of ice. Basically, this is frozen drizzle.



Ice Crystals. Generally occurring in very cold regions, they are falling crystals of ice in the form of needles, columns, or plates. Also called 'diamond dust', ice crystals appear like fog with individual water particles forming directly as ice. The shape of the individual ice crystals causes the 'light pillar' optical effect above the light source.



Have you experienced the kinds of precipitation listed above? Discuss with your group.

WRAP-UP

At the beginning of this reading, you showed the differences in the weather between Burma (or somewhere else) and Indianapolis by drawing. Now you know other ways of expressing weather, so you are going to post a short essay about the different weather phenomena between Burma and Indianapolis using those weather variables. Your essay is to tell readers about how the weather is different or similar between Burma (or any other region you used to live) and Indianapolis. Readers of this newsletter are primarily people who were born and have lived only in Indiana. Use space below to develop outline of your essay. You can also use some pictures on your blog post.

LESSON 3: LET'S DEFINE WEATHER VARIABLES (AGAIN?)

GOALS OF THE LESSON

Define weather phenomena and variables

What are variables of weather?

What do we want to talk about when we say weather?

Would the aspects of weather be different in different geographic locations?

Compare different and similar weather phenomena in different parts of the world, Burma and the U.S.

MATERIALS

Reading Material on Weather Variables (*See previous week*)

Computers for posting the blog

4 Water buckets (1 for Soda bottle demo, 3 for galileo thermometer)

PETE drink bottles

Post it notes

3 galileo thermometer

1 pack Ice

ACTIVITIES OF THE LESSON

Review what we did last week .

ACTIVITY 1: READING ABOUT WEATHER AND WEATHER VARIABLES (ABOUT 25 MINUTES)

Group activity

We will pick up from where we stopped in the reading material. In a group of three (or four), students will read about weather and weather variables. The students will accomplish the talking points/activities within the group. One of the discussion questions asks the students to compare the weather in Chin State (or a place they have lived in) to the weather in Indiana. The idea is to foreground the writing of the essay in Activity 3.

Ground rules for reading:

The goal is to understand the meaning of the text, not simply read it through. If any idea in the text does not make sense, stop and discuss.

Another important goal is that everyone understand the reading material. Make sure everyone is on the same page. Stop and check each other's understanding occasionally.

There might be some parts that do not make sense to everyone in the group. Mark those parts and talk about them when we discuss as a whole group.

As you read the text, you may come up with new, related questions, which is great. Jot down those questions so that you can share your questions with other people and pursue answers to those questions.

Groups that have completed reading discussion can start working on the essay by developing an outline.

ACTIVITY 2: DISCUSSING WEATHER VARIABLES AND INTRODUCING GALILEO'S THERMOMETER (ABOUT 20 MINUTES)

Whole class sharing

As a whole class, gather everyone in a circle and share what each group has. Discuss how students understand the weather variables and if there are other weather variables they have come up with. Clarify ideas that are unclear about the reading. Explore questions that came up during the discussion.

Heat section:

Ask how we measure temperature. They have probably seen some thermometer. Show them Galileo thermometer. Ask them to guess how it might work. Why?

Then, we will do a simple experiment/demo. Possibly, we can place one in an ice water bucket, another in a hot water bucket, and another at room temperature and observe the change. "Do they work in the way you expected?"

Tell them that in the course of the discussion, they will make at least 4 observations of the Galileo Thermometer. Their first observation will be showing them the bucket of ice and placing the thermometer in. It will take no more than 5 minutes for the glass bubbles to float up. The Galileo Thermometer can remain in the center of the circle.

Pressure:

The discussion of the reading will continue, in the air pressure section, demonstrate the Cut Soda Bottle filled with water to illustrate air pressure. At the end of the section, ask the students to make observations again on the Galileo Thermometer. The glass bubbles should start to sink.

Continue with the discussion of the motion section and moisture section.

Finally, do the wrap-up.

**ACTIVITY 3: TELL YOUR WEATHER STORY WITH THE WEATHER VARIABLES THAT WE IDENTIFIED.
(ABOUT 20 MINUTES)**

Individual

Now that students know more about weather variables , they will be writing a short essay (one-half to one page long) for a newsletter. Your essay is to explain how the weather is like in Burma and/or any other region in which you used to live and how your experience of weather was like when you first moved to Indiana. Readers of this newsletter are primarily people who were born and have lived only in Indiana.

Use the box in the worksheet to develop an outline. Then, type their story in the blog. Students will be given time to enter their stories into the blog. They will be encouraged to add images to their blog post. If they have not finished they can complete it at home.

ACTIVITY 4: WRAP-UP: REMAINING QUESTIONS AND INTRODUCTION OF THE GALILEO THERMOMETER

Ask them to write any lingering question or vocab they don't understand on post-it. Then, they will post them on the chart paper.

The "end of day question" that will be talked about NEXT WEEK will be how they think the Galileo Thermometer works.

FACILITATORS NOTE

The students were only able to do the heat and pressure section of the reading. There was some confusion regarding air pressure.

LESSON 4: WHAT IS AIR PRESSURE?

GOALS OF THE LESSON

Show that air particles exist

Demonstrate that air pressure is a push of air particles on a surface

Air particles move from a higher pressure area to a lower pressure area

Perform simple air pressure experiments

Explain the experiments in terms of air pressure

MATERIALS

Worksheet on Air Pressure

Station 1: cup, index card, source of water

Station 2: water bottle with cap, push pin, source of water

Station 3: water bottle, balloon, push pin, source of water

Station 4: glass bottle, paper

Chart paper, markers

ACTIVITIES OF THE LESSON

Share what we did last week. Students will be asked for ideas regarding air pressure. Then they will be informed that they are going to explore air pressure further and they will present it to the class. This may also be an opportunity to remind students to blog what they learned at the end of the lesson.

ACTIVITY 1: EXPLORING IDEAS ABOUT AIR PRESSURE (ABOUT 40 MINUTES)

Facilitator should set-up the materials in each station prior to the activity. See Facilitators' note for details

Group activity

Students will work in groups of 3-4. Two groups will be assigned to the different stations initially. The students will rotate through all stations to complete the worksheet.

Facilitators should be ready to guide their discussion at each station.

Encourage them take pictures and videos.

ACTIVITY 2: REPORTING ABOUT AIR PRESSURE (ABOUT 30 MINUTES)

Group activity

“Imagine you have magic glasses so that you can see air particles. What would they look and move like in the experimental setting that you explored? How can that explain what you observed?”

After finishing the activity, students will be given time to prepare (10 min)

Students are free to present what they have learned in any medium they see fit

ACTIVITY 3: WRAP UP:

Individual or Group activity

Students will post a short blog entry of at least one thing that they learned that day. They will be encouraged to post pictures.

Blog post prompt: “We did very cool experiments today. Let’s tell a story about what we did today. This is to inform other people (like your friends, parents, and siblings) about what we did and explain them how it works. Create a post and write a short paragraph about what we did with an explanation. You can also add pictures from the lab or your drawing!”

FACILITATORS’ NOTE

Station 1 : What keeps the index card from falling?

The cup must be filled to the brim with water. When placing the index card, it should create a seal with the cup. Air pressure keeps the index card from falling - this shows that air pressure is strong enough to “hold” the weight of the water.

Station 2: What stops the water from coming out?

After filling the bottle, the cap must be kept on. Puncturing the bottle with the push pin will not let the water come out because there is no air pressure pushing on the water. If you remove the cap, then air will push on the water and so it comes out.

Station 3: What is inflating the balloon?

The bottle is filled with water and the deflated balloon is placed over the mouth of the bottle. It does not matter if some liquid spills out of the bottle as the balloon is placed. Take care to ensure that the balloon is really deflated. Puncturing the bottle and squeezing some of the water out will inflate the balloon. When water goes out, there is now extra “space” for air. So outside air pushes in, inflating the balloon. As balloon inflates, inside air (the one between the balloon and the water) gets smaller volume again, so pressure increases. A more controlled experiment would show that volume of water leaving the bottle is same as volume of inflated balloon.

Station 4: Would the paper ball go into the bottle?

The paper ball should be a size smaller than the mouth of the bottle. The paper ball should be placed only on the neck of the bottle. Blowing into the bottle means you are blowing in fast speed air molecules. This means that the area by the mouth of the bottle has low pressure and so the paper ball comes out instead. The same thing happens when you blow on the side.

The students were so engaged in Activity 1 that we had little time left for the other activities. The students were able to draw their ideas of what Air Pressure is as a group but were not able to report.

WORKSHEET ON AIR PRESSURE

Name: _____

Visit four stations and try each challenge. And think about why it happens and draw what you think is happening on the blank space. Once you are done, get a sticker before moving to the next station. An assistant in each station will help you to explore.

What keeps the index card from falling?

In this station, you have:

1 cup
1 index card
water

Fill a water cup with water, place an index card on top of the cup, and turn it upside down carefully.

Why does the water not come out?



Group Name: _____

What stops the water from coming out?

In this station, you have:

1 water bottle with cap
1 push pin
water

Fill the water bottle with water, cap it, push a pushpin in the middle of the bottle (indicated by the red arrow), and remove it. Does the water come out? Why not?



How can you make water come out through the small hole in the bottle? Why does it work?

Name _____

Group Name: _____

What is inflating the balloon?

In this station, you have:

1 water bottle

1 balloon

1 push pin

water

Fill a water bottle with water, place a deflated balloon over the mouth of the bottle, and make a small hole using a pushpin (indicated by the red arrow). Then, gently squeeze the bottle to get some water out. What happens to the balloon? Why do you think this happens?



Would the paper ball go into the bottle?

In this station, you have:

1 glass bottle

Small piece of paper

Make a paper ball and place it into the bottle as shown in the picture. Blow air into the bottle. What happens? Is it what you expected? Why does this happen?



Now, try this. Turn the bottle to the side and blow the bottle from the side. What happens? Why?

LESSON 5: DO WE NEED TO KNOW ABOUT AIR PRESSURE?

GOALS OF THE LESSON

Explain the mechanisms of the four experiments from the previous week

Discuss how air pressure impacts weather

Making connections between air pressure experiments and air pressure shown in weather forecast

Post a blog and comment on each other's blogs

MATERIALS

Laptop

Posters from last week (Students used chart paper to illustrate ideas)

Chart Paper, Markers

ACTIVITIES OF THE LESSON

ACTIVITY 1: SHARING WHAT WE KNOW ABOUT AIR PRESSURE (ABOUT 20 MINUTES)

Group activity

"We have thought and talked about interesting phenomena of air. Probably, you have some ideas about what air pressure is and how air pressure affects weather phenomena. Today, we are going to reflect on what we know about air pressure and what we want to know more about air pressure. We will first discuss it in our group and then post a summary of what we know and what we want to know in our blog."

Students will be instructed to sit with their small groups. Their folders containing their worksheets from last week will be given back to them, as well as the posters that they made last week. Still images from last week's experiments will be shown. As there would be students who were not present during last week's activities, they may need to join groups that were formed previously.

To start discussion, two prompts will be written on the board : " What do you know about Air Pressure? What do you want to know about Air Pressure?"

The idea is to clarify how we think about air and air pressure : that air is made up of particles and air pressure is a force, etc; to make connections between air pressure experiments and air pressure shown in weather forecast.

Each group will be given chart paper and markers so that they can write down their ideas.

ACTIVITY 2: BLOGGING ABOUT AIR PRESSURE (ABOUT 40 MINUTES)

Group activity and Individual

"Let's share it out."

Laptops will be given to each small group. They will be instructed that they will be blogging about what they have discussed.

Facilitator will model how to blog - starting from registering, to creating a post.

The students will answer the main prompt. They can also choose another prompt to work on (1- explain about their experiments; 2- discuss how air pressure impacts weather) that are available online. If students have more time, they can blog on old prompts as well.

ACTIVITY 3: COMMENTING ON THE BLOGS AND WRAP-UP (ABOUT 10 MINUTES)

Individual

Hopefully, at this point, there will be several blogs up and running. The students will be encouraged to comment on each other's blog post.

They will be encouraged to utilize Free Space for any exciting things they may want to share.

FACILITATORS NOTE

The students did not get to comment on the blogs but at the end of the session we had several blogs posted.

LESSON 6: HOW DOES AIR PRESSURE IMPACT WEATHER?

GOALS OF THE LESSON

Construct a graphic organizer that can draw out students' ideas about weather

Read and share about how air pressure relates to different weather phenomena

MATERIALS

Readings of 4 different topics on Air Pressure and Weather

Chart Paper, Markers

Tape (to place chart paper on the wall)

vacuum pump & chamber, marshmallow, a small cup with water, a small bag of chips

Globe

ACTIVITIES OF THE LESSON

ACTIVITY 1: CONSTRUCTING A GRAPHIC ORGANIZER (RECAP: ABOUT 10 MINUTES; GRAPHIC ORGANIZER: ABOUT 10 MINUTES)

Group activity & Whole Class Discussion

Students will be asked what we did the previous week and give a recap. Images of the posters of their ideas about air pressure and their questions will be projected on screen.

"One of the questions that we had at the end of the day was : What will happen to person in extreme high/low pressure? (The picture of the questions that they had will be shown and highlighted). To answer that, we will demonstrate it with a simple experiment." Facilitator will then show what happens to a marshmallow/peep inside a vacuum chamber"

"We have talked about air pressure for the last couple of weeks and we have a lot of ideas about air pressure. We now have to take a step back and see how it relates to weather. So to help us, we are going to put our knowledge about weather that will help us see how weather phenomena are related to each other" (The idea is to put back air pressure and other weather variables in the context of weather)

Students will break out in small groups of 4 and will be given chart paper and markers. They will be asked to construct a graphic organizer. The main prompt is "What makes up weather?" Facilitator will model construction of graphic organizer by adding "temperature," and "air pressure" as components under weather. Then, underneath the two components, the facilitator writes about "how we experience temperature and air pressure." (e.g., Temperature: when the temperature is high, we feel hot, and when it's low, we feel cold. There is high and low air

pressure. When there is low high pressure, it's hard to breathe. Because of air pressure, water does not come out from holes of a water bottle.)

Students will then be asked to think of 8 more things that make up weather and their experiences about each. (10 minutes)

Students will then asked to write about how each of them is related. Facilitator will model. (e.g., when it rains, the temperature is usually low.) The students will do the same for the additional 8 things that they have written in their graphic organizers.

Students share what connections that they have. Students will be encouraged to come up with as many connections as they can.

ACTIVITY 2: JIGSAW READING (READING: ABOUT 10 MINUTES; SHARING WITH GROUP MEMBERS: ABOUT 10 MINUTES)

Group activity

Students will be asked to hang their poster paper on the wall. Check on what connections they have come up and see what connections that they made with air pressure. If they came up with some connections, talk briefly about it. "What is connection between air pressure and other weather phenomena?" Then, transition to reading about air pressure and weather.

Each group member will be given a different reading material. The members will go to their reading group (members who were given the same reading material) and discuss about the reading material.

Each facilitator will facilitate the reading comprehension.

The reading material is divided into 4-5 smaller sections.

Students will take turns to read out loud and interpret the section that they read. First, two people are responsible on the first section. One person reads out loud and the other person will explain ("in your words") what was read. Then, another group of two people does the same.

After all the sub-sections are read and interpreted, students will come up with three main points about the relationship between air pressure and weather phenomena or living things. By the end of this reading activity, each member should be able to teach their original group members about their own reading.

Once it is done, they will go back to their original group. If a reading group finishes earlier than others, they can read other materials as well.

ACTIVITY 3: REVISITING THE GRAPHIC ORGANIZER (ABOUT 10 MINUTES)

Group Activity

After reading, the members will go back to their original groups. Each person teaches what they learned from their reading to other group members.

Students will take their chart paper to their group. Based on the new learning, they will make more connections in their graphic organization based on what they know about air pressure and air.

Write down on another chart paper, what is not clear yet and what other questions they have about air pressure and weather.

ACTIVITY 4: SHARE OUT

Whole Class

All groups will post their graphic organizers on the board and talk about it. Group members will explain the “components” of weather that they have written and how they all relate to each other. They will also talk about the questions that they came up with.

After each group’s presentation, the audience will comment on the group presentation, if there is any connection that they did not have on their chart paper or if they know answers to the questions posed by the presenting group.

ACTIVITY 5: BLOG (ABOUT 10 MINUTES)

Individual

Students will blog about their weather story. The prompt is : “ Letter to Zazo: My Air Pressure and Weather Story”.

“ You have made contact with an extraterrestrial being named Zazo. Zazo lives in a planet where there is no air pressure and the weather is constant. Zazo will soon be moving to Earth. Zazo needs your help to prepare him for his move to earth. Think about how you experience weather. You can choose your favorite weather or your least favorite weather. How does air pressure impact it? Write a letter to Zazo and give him advice as to how he can live on Earth now that he has to deal with air pressure and weather”

FACILITATORS NOTE

We only got to Activity 4. We had few students in attendance as well.

READING 1: WHAT ARE IMPACTS OF HIGH AND LOW AIR PRESSURE ON HUMAN BODIES?

You've got one ton of air pressing on you, the same as a small car. Really? Yes, really. We've assumed that you're at sea level and that the area of the top of your head and shoulders is 0.1 square meters, but that's not unreasonable. So how could it be possible that you're carrying around the equivalent of a small car all the time?



The weight of air Even though they're too tiny to see, all the molecules of air in the atmosphere above your head weigh something. And the combined weight of these molecules causes a pressure pressing down on your body of 10,000 kg per square meter. This means that the mass of the air above the 0.1 square meter cross section of your body is 1,000 kg, or a ton.

If you tried to lift a small car, you'd certainly notice it, so why don't we notice that there's a ton of air pressing down on us? Well, the air exerts this force in all directions, so as well as pushing down on us, it also pushes up and balances out the force on our bodies so that we don't collapse.

Crushing pressure Human bodies are used to air pressure. The air pressure in our lungs, ears and stomachs is the same as the air pressure outside of our bodies, which ensures that we don't get crushed. Our bodies are also flexible enough to cope when the internal and external pressures aren't exactly the same. Aeroplanes need pressurized cabins to compensate for the lower air pressure at high altitudes. Despite this artificial atmosphere, the air pressure inside an aeroplane is not the same as at sea level. You might have noticed that if you drink from a plastic bottle during a flight and put the lid back on, when you land the bottle will be crushed. This is because the air in the bottle is at the lower pressure of the cabin and it can't withstand the higher air pressure at ground level.

You've probably also noticed that your ears pop during the take off or landing of a flight. This is caused by the difference in air pressure on either side of your ear drums and the only way to equalize the pressures is to yawn, suck a sweet or breathing out whilst holding your nose.

Source: <http://www.physics.org/facts/air-atmospheric-pressure.asp>

What would happen with too much air pressure?

Who might experience extreme pressure? Deep sea divers! Although it is not "air" pressure, but based on what divers experience we can infer what would happen to our bodies under extremely high air pressure. The body experiences what is called 'Compression Pains' in the new U.S. Navy Diving Manual (3- 10.8). it is referred to as compression arthralgia in other texts (Edmonds and Bove). It is the result from incr

eases in external pressure surrounding the body. These pains affect the joints and may occur in almost any diver. They have been experienced in the knees, shoulders, fingers, back, hips, neck, and ribs. Occasionally, severe low back pain or xiphisternal pain may occur (Bove). The pains are often described as deep aching pains, similar to those of Type I decompression sickness. However, the pains may be relatively sudden in onset and initially intense. These pains may be accompanied by “popping” of joints or a dry, “gritty” feeling within the joint.

Source: <http://www.scuba-doc.com/cmprarth.html>

People With Joint Pain Can Really Forecast Thunderstorms

The summer brings many thunderstorms to the east coast of the United States, and one of the nation’s leading joint specialists, Javad Parvizi, M.D., Ph.D., of the Rothman Institute at Thomas Jefferson University Hospital, says you should believe your grandmother, friend or co-worker when they tell you it’s going to rain—even if it’s simply because their aching knees, hips, hands or shoulders “say so.”

Dr. Parvizi, who is also director of clinical research at the Rothman Institute at Jefferson, and associate professor of Orthopaedic Surgery at Jefferson Medical College of Thomas Jefferson University in Philadelphia, explains that even though individuals can experience pain fluctuations with the slightest change in barometric pressure, most patients report significant increases in pain before and during severe changes in weather, like summer downpours and thunderstorms.

“The phenomenon of people being able to forecast precipitation, especially rain, due to the level of their joint pain is real,” says Dr. Parvizi. “It is not in the patient’s head. There is science to back it up.”

Weather-related joint pain is typically seen in patients with osteoarthritis, rheumatoid arthritis, and other arthritic conditions. It can affect any load-bearing joint, but is most common in hips, knees, elbows, shoulders and hands. The joints contain sensory nerves called baro-receptors which respond to changes in atmospheric pressure. These receptors especially react when there is low barometric pressure, meaning the atmosphere has gone from dry to moist, like when it is going to rain.

“When pressure in the environment changes, we know that the amount of fluid in the joint or the pressure inside the joint fluctuates with it,” says Dr. Parvizi. “Individuals with arthritic joints feel these changes much more because they have less cartilage to provide cushioning.”

Dr. Parvizi says that sometimes the pain is due to inflammatory mediators around the joint, like with rheumatoid arthritis conditions and can often be helped by keeping the joints warm or icing them (depending on preference), massage therapy, and applying pain killing creams and ointments. Other treatments may include non-steroidal anti-inflammatory drugs (NSAIDs), site-specific steroid injections, and long-term use of certain supplements like Omega-3 (which is used to reduce inflammation) and

glucosamine and chondroitin, which have been shown, in combination, to significantly reduce arthritis pain and maintain healthy cartilage. For patients who have suffered a long time and exhibit signs of end stage arthritis (no cartilage left to cushion the joint), Dr. Parvizi suggests that joint replacement should be considered.

Source: <https://www.sciencedaily.com/releases/2008/05/080530174619.htm>

READING 2: WHAT IS AIR PRESSURE AND HOW DOES IT IMPACT WEATHER PHENOMENA?

Air has weight

If a person were to climb a tall mountain, like Mauna Kea on the Big Island of Hawaii, where the summit reaches to 13,796 feet (4,206 meters), contracting altitude sickness (hypoxia) is a high probability. Before ascending to the summit, visitors must stop at the Information Center, located at an altitude of 9,200 feet (2,804 m) where they are told to acclimatize to the altitude before proceeding further up the mountain. “Well, of course,” you might say, “After all, the amount of available oxygen at such a high altitude is considerably less as compared to what is present at sea level.”

But in making such a statement, you would be *wrong!*

In fact, 21 percent of Earth's atmosphere consists of life-giving oxygen (78 percent is composed of nitrogen and the remaining 1 percent a number of other gases). And the proportion of that 21 percent is virtually the same at sea level as well as at high-mountain altitudes.

The big difference is not the amount of oxygen present, but rather *density and pressure*.

The pressure of all the air above our heads is the force that pushes air into our lungs and squeezes oxygen out of it and into our bloodstream. As soon as that pressure diminishes (such as when we ascend a high mountain) less air is pushed into the lungs, hence less oxygen reaches our bloodstream and hypoxiation results; again, not due to a lessening of the amount of available oxygen, but to the lessening of atmospheric pressure.

Highs and lows

So how does atmospheric pressure relate to daily weather patterns? No doubt you've seen weather forecasts presented on television; the on-camera weathercaster making reference to high pressure and low pressure systems. What is that all about?

Basically, in a nutshell, every day the heat of the sun varies all over the Earth. Because of unequal solar heating, temperatures vary over the entire globe; the air at the equator is much warmer than at the poles. So the warm, light air rises and spreads toward the poles and the colder, heavier air sinks toward the equator.

So why do we generally associate high pressure with fair weather and low pressure with unsettled weather?

High pressure systems are “domes of density” that press down, while low pressure systems are akin to “atmospheric valleys” where the density of the air is less. Since cool air has less of a capacity to hold water vapor as opposed to warm air, clouds and precipitation are caused by cooling the air.

So by increasing the air pressure, the temperature rises; underneath those high pressure domes, the air tends to sink (called “subsidence”) into the lower levels of the atmosphere where temperatures are warmer and can hold more water vapor. Any droplets that might lead to the formation of clouds would tend to evaporate. The end result tends to be a clearer and drier environment.

Conversely, if we decrease the air pressure, the air tends to rise into the higher levels of atmosphere where temperatures are colder. As the capacity to hold water vapor diminishes, the vapor rapidly condenses and clouds (which are composed of countless billions of tiny water droplets or, at very high altitudes, ice crystals) will develop and ultimately precipitation will fall. Of course, we could not forecast zones of high and low pressure without employing some sort of device to measure atmospheric pressure.

Enter the barometer

Atmospheric pressure is the force per unit area exerted by the weight of the atmosphere. To measure that weight, meteorologists use a barometer. It was Evangelista Torricelli, an Italian physicist and mathematician who proved in 1643 that he could weigh the atmosphere against a column of mercury. He actually measured pressure converting it directly to weight. The instrument Torricelli designed was the very first barometer. The open end of a glass tube is placed in an open dish of mercury. Atmospheric pressure forces the mercury to rise up the tube. At sea level, the column of mercury will rise (on average) to a height of 29.92 inches or 760 millimeters.

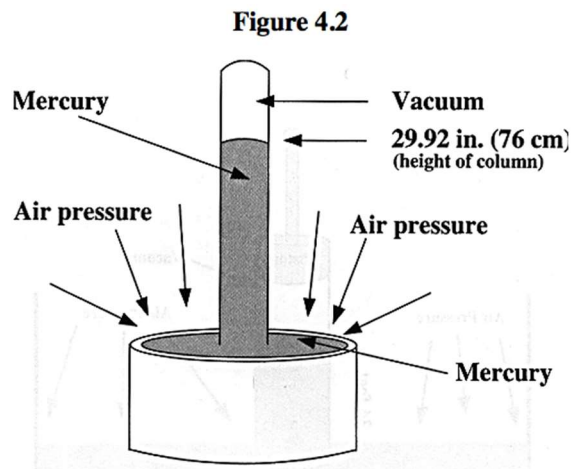


Figure 4.2. Torricelli's mercury barometer. The weight of the mercury in the tube is balanced by the force of the air on the mercury in the dish.

Why not use water instead of mercury? The reason is that at sea level, the water column would be about 34 feet high! Mercury on the other hand, is 14 times denser than water and is the heaviest substance available that remains a liquid at ordinary temperatures. That permits the instrument to be of a more manageable size.

Source: <http://www.livescience.com/39315-atmospheric-pressure.html>

READING 3: HOW DO HURRICANES FORM?

Hurricanes are the most awesome, violent storms on Earth. People call these storms by other names, such as typhoons or cyclones, depending on where they occur. The scientific term for all these storms is tropical cyclone. Only tropical cyclones that form over the Atlantic Ocean or eastern Pacific Ocean are called "hurricanes." Whatever they are called, tropical cyclones all form the same.



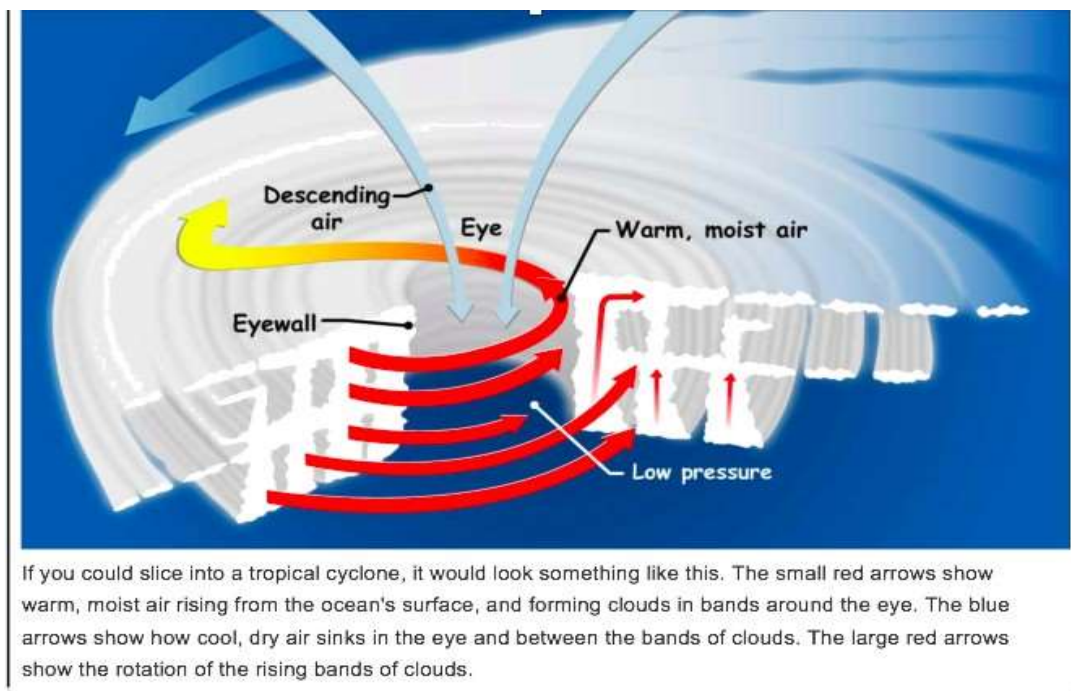
Tropical cyclones are like giant engines that use warm, moist air as fuel. That is why they form only over warm ocean waters near the equator. The warm, moist air over the ocean rises upward from near the surface. Because this air moves up and away from the surface, there is less air left near the surface. Another way to say the same thing is that the warm air rises, causing an area of lower air pressure below.

Air from surrounding areas with higher air pressure pushes in to the low pressure area. Then that "new" air becomes warm and moist and rises, too. As the warm air continues to rise, the surrounding air swirls in to take its place. As the warmed, moist air rises and cools off, the water in the air forms clouds. The whole system of clouds and wind spins and grows, fed by the ocean's heat and water evaporating from the surface.

Storms that form north of the equator spin counterclockwise. Storms south of the equator spin clockwise. This difference is because of Earth's rotation on its axis. As the storm system rotates faster and faster, an eye forms in the center. It is very calm and clear in the eye, with very low air pressure. Higher pressure air from above flows down into the eye.



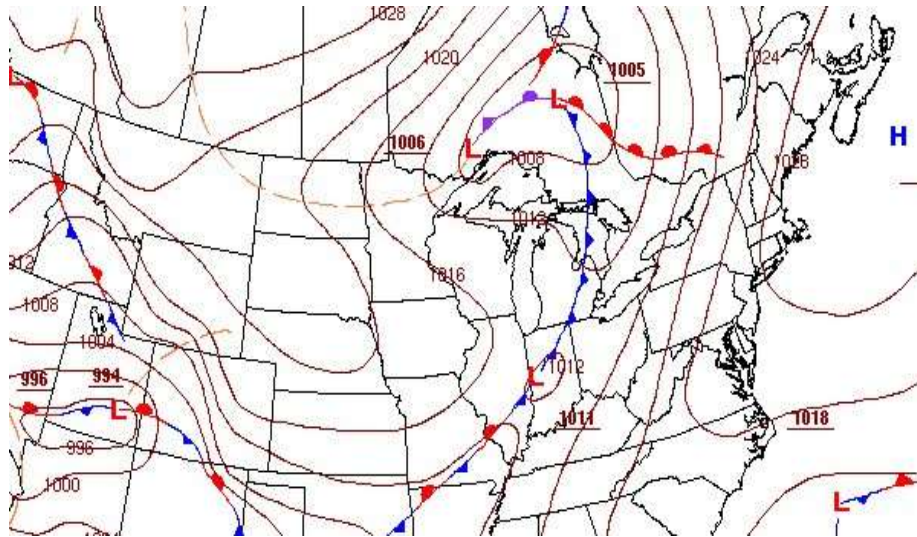
Figure 1 A cumulonimbus cloud. A tropical cyclone has so many of these, they form huge, circular bands



When the winds in the rotating storm reach 39 mph, the storm is called a "tropical storm." And when the wind speeds reach 74 mph, the storm is officially a "tropical cyclone," or hurricane. Tropical cyclones usually weaken when they hit land, because they are no longer being "fed" by the energy from the warm ocean waters. However, they often move far inland, dumping many inches of rain and causing lots of wind damage before they die out completely.

Source:<http://spaceplace.nasa.gov/hurricanes/>

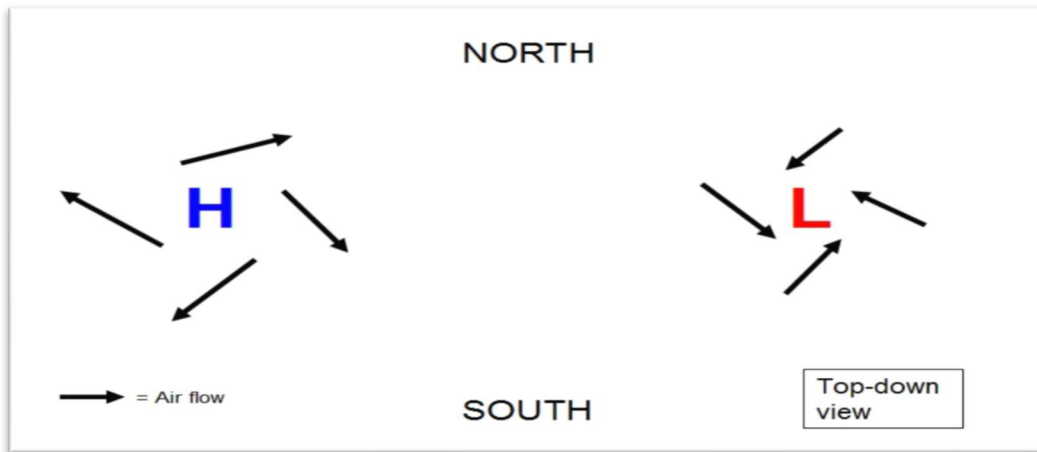
READING 4: HIGH AND LOW PRESSURE



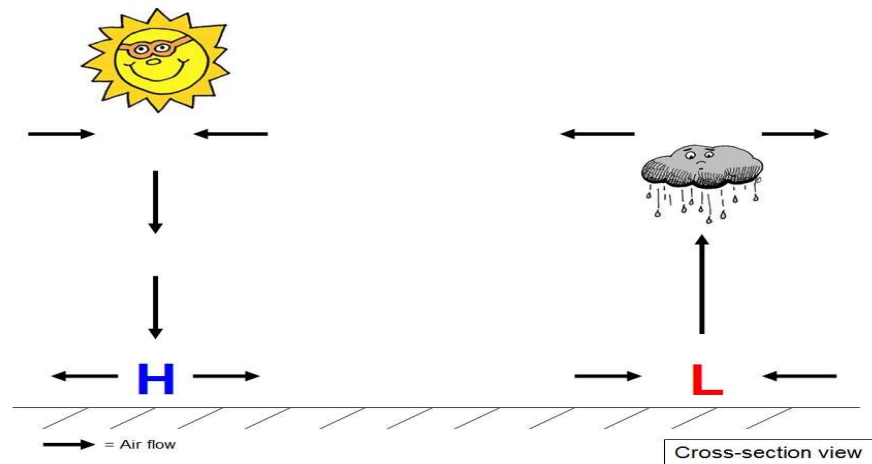
If you are a regular viewer of weather broadcasts, chances are you've heard the following from your local TV meteorologist: "plenty of sunshine is in store today as high pressure is in control over the area." Or: "expect rain to spread into the area as a low pressure system approaches." It is well established that high pressure is generally associated with nice weather, while low pressure is generally associated with cloudy, rainy, or snowy weather. But have you ever wondered why?

In order to understand the types of weather conditions generally associated with high and low pressure systems, we must think "vertically." The motion of air in the atmosphere above our heads plays a large part in the weather we experience here at earth's surface. Basically, air cools as it rises, which can cause water vapor in the air to condense into liquid water droplets, sometimes forming clouds and precipitation. On the other hand, sinking air is associated with warming and drying conditions. So the first important point to keep in mind is rising air = moistening, sinking air = drying.

So what does this have to do with high and low pressure? Well, as you may have guessed, high pressure is associated with sinking air, and low pressure is associated with rising air. But why? The answer has to do with the typical air flow around high and low pressure. Physically, it seems to make sense to have air flow from high pressure to low pressure. For reasons I won't get into in this post, the airflow (due to the Earth's rotation and friction) is directed slightly inward toward the low pressure center, and slightly outward away from the high pressure center:



The slightly inward moving air in low pressure causes air to converge and since it can't move downward due to the surface, the air is forced upward, leading to condensation and precipitation as discussed earlier. The opposite occurs with high pressure. Air is moving away from the high pressure center at the surface (or "diverging") so as a result, air from above must sink to take its place. The surface flow is accompanied by the opposite behavior at upper levels of the atmosphere, as depicted in this schematic diagram:



Now there is much more to it than just high pressure = nice weather and low pressure = bad weather (otherwise I would be out of a job!), but hopefully after reading this, you have a better understanding of why meteorologists talk about pressure systems.

Source: Weather Works LLC

LESSON 7: WHAT WORDS DO WE HAVE TO DESCRIBE WEATHER?

GOALS OF THE LESSON

- Revisit challenging words and provide definitions
- Explore Ventusky and figure out patterns of weather variables
- Create a short vlog to talk about what they learned

MATERIALS

- Post-it notes, different colors
- Chart Paper, Markers
- Laptops
- Tape
- Word Patch Board, Velcro dots

ACTIVITIES OF THE LESSON

ACTIVITY 1: OPENING EXERCISES AND REVIEW OF WHAT WE DID PREVIOUSLY (ABOUT 5 MINUTES)

Whole Class

- Welcoming remarks given. Short overview of what we have left to do for the next 4 weeks.
- Students who were around on Week 6 will describe what we did previously. Show images of graphic organizer from Week 6.
- Also, tell them what we will be doing for the rest of the semester.

ACTIVITY 2: WORD GAME (ABOUT 15 MINUTES)

Group Activity

Students will be divided into 2 groups. Each group will come up with a list of 15 words which will be used for the game within 2 minutes. The groups will write one word per page on a booklet that will be submitted to the facilitators. The groups will guess the word list provided by the opposing team.

The game will be played as follows. A group will be asked to sit facing the class. Student 1 will sit facing his/her groupmates. The facilitator will show a word from the list to Student 1 and the rest of the class. Student 1 will provide clues about the word to his group. . If the group guesses the word, Student 1 goes back to the end of the line and sit facing the class and Student 2 will take Student 1's seat. Student 2 will now give clues. Facilitator will keep track of the words the team guessed.

The goal is to guess as many words in the list within 4 minutes. Students can say “pass” and move to the end of the line.

ACTIVITY 3: DEFINING CHALLENGING WORDS (15 MINUTES)

Group Activity/ Whole Class

The facilitators will ask if there are confusing words still. Collectively, we will make a list of words. Then we will go over two of them and define them. We will probably define air pressure and precipitation.

On one chart paper it will say: “Air Pressure is....” ; and on another it will say “Use “Air Pressure” in a sentence”.

The groups will be given two different colored post-its

Group 1 will try to define Air Pressure by completing the sentence. Group 2 will use the word Air Pressure in a sentence. They will write their answers on the post-its and place it on the appropriate chart paper. Facilitators will go over the students’ responses.

We will do the same for “Humidity” and “Precipitation”.

For “Humidity”, Group 2 will try to define Humidity, and Group 1 will use the word in a sentence.

For “Precipitation”, the group will switch roles again.

We may also use different words depending on how the word game goes. We will do only two words.

After the words have been defined and used in sentences, facilitator will introduce the use of the word patch board. Say “We have defined and used in sentences the words: air pressure, humidity, and precipitation. Throughout the rest of the sessions, we will use this word patch board to create a collection of words that we find challenging. We will continue to revisit our collection of words throughout the rest of the semester.” Facilitator will then ask students to write the three words down on colored papers and place velcro dots on them and place them on the word patch board. Facilitator then asks the students what other words should be added on the list.

ACTIVITY 4: EXPLORING VENTUSKY (ABOUT 30 MINUTES)

Group Activity

Students will work with small groups. Their goal is to explore the Ventusky website and come up with 5 observations. They will jot down their ideas on the chart paper. Each member will be provided with a marker.

The students will explore the website Ventusky. Ventusky operates real time - so what you see is what is happening currently. Some things to think about while exploring

Explore the weather variables by pressing on the “buttons” on the left side of the map. What information can we get? Toggle with the drop-down menus and compare/contrast what the map shows. What could this mean?

What do the color scales mean for each weather variable? What about the moving lines?

How are weather variables related to each other? For example, is there a relationship between air pressure and wind? Are there other patterns that you can see when comparing weather variables?

In the “zoomed” out view, what patterns can we identify for each weather variable in terms of map location?

Choose a location in the map either by using the search bar or scrolling on the map. Look at the weather forecast for that location.

What ways can Ventusky be used for?

ACTIVITY 5: VLOGGING ABOUT VENTUSKY (ABOUT 25 MINUTES)

Groups of 3

Show SMD’s vlog on California weather. Alternatively, any vlog about a weather phenomenon from a different locality can work for this activity.

Using their phones, students will record a vlog which they will post on Facebook. They will share their thoughts on their explorations in terms of :

3 things they learned (interesting patterns, insights)

3 things they want to know more about

Students will do a group vlog and post it on the Facebook page of RESET. The vlog prompt is as follows:

You will first introduce yourselves, talk about what you learned and ask about the things you still want to know more about.

When students have posted vlogs, they would be encouraged to watch each other’s vlogs and make comments about the vlogs.

FACILITATOR’S NOTE

We spent a lot of time on the game and the definition of words. We did not have a lot of time exploring Ventusky. The students created short vlogs.

LESSON 8: HOW DO WE COMPARE WEATHER IN TWO CITIES?

GOALS OF THE LESSON

Revisit challenging words and provide definitions

Compare weather between Sydney and KL

Temperature

Other weather variable

Introduce the idea of weather pattern over a year

Explore web resources to explore different weather variables

Create a short vlog to respond to Ines's question

MATERIALS

Post-it notes, different colors

Markers, chart papers

Word patch board

Laptops

ACTIVITIES OF THE LESSON

ACTIVITY 1: OPENING EXERCISES AND REVIEW OF WHAT WE DID PREVIOUSLY (ABOUT 10 MINUTES)

Whole Class

Welcoming remarks given.

Students who were around on Week 7 will share their observations.

ACTIVITY 2: REVISITING OUR WORD LIST (ABOUT 10 MINUTES)

Small Group/ Whole Class

We are bringing back the words we had from previous week's word list.

Students will be given post-its: Define the word and compose a sentence that uses the word.

The words for this week are: humidity and wind.

ACTIVITY 3: “ WOULD THE TEMPERATURE IN FEBRUARY BE DIFFERENT IN KUALA LUMPUR AND SYDNEY?”
(ABOUT 5 MINUTES)

Small Group

Say, “We have a friend here who has a question.”

Show Ines’ video. Students will probably look up information on the web. Alternatively, a pre-made video with a weather-related question can work as well.

“What was her question? What do you think? Would it be similar or different? (have them guess) Let’s find that out! Let’s do quick search and find out what the temperature is like in Feb in Sydney and KL.”

Students will do a quick search and find it out.

Get to an answer to Ines’s question.

ACTIVITY 4: BRAINSTORM ACTIVITY: WHY IS TEMPERATURE DIFFERENT IN SYDNEY AND KUALA LUMPUR?
(ABOUT 10 MINUTES)

Whole class

So now that we see that the temperature is different for Kuala Lumpur and Sydney, generate ideas why temperatures are different in Sydney and Kuala Lumpur.

Before doing a web search, ask students to share ideas of what factors may cause temperature differences and write these down on the board.

Depending on who come to the program, we may or may not turn this into a small group activity. If there are more “vocal” ones present, ask them to discuss in a small group for a few minutes and share it out.

To help students answer the question, students will look at the globe and some maps so they have an idea of what the terrain looks like.

After giving students some time to explore, facilitator will solicit students’ ideas and write them down on the board. (Potential ideas: Distance from the equator; distance from water; mountain vs. valley; distance from a big mountain, time of a year, etc.). We would like to keep this list of potential factors that affect weather.

Transition questions: Would just knowing the temperature be enough for Ines and her family to prepare for their trip? What other variables would be important to look at when we want to compare two different places? (The idea is to draw out ideas about air pressure, wind, humidity, and precipitation). Generate ideas and write them on the board.

If possible, have a student write on the board.

ACTIVITY 5: RESEARCHING WEATHER PATTERNS IN SYDNEY AND KL (20 MINUTES RESEARCH; 5 MINUTES PREPARATION; 15 MINUTES PRESENTATION)

Small Group/ Whole Class

Transition Question: Would the answer be different if we compare Sydney and Kuala Lumpur in July? Probably not.

Now, we let's check on actual data. Use the laptops to research on the web regarding the weather patterns over the course of a year of the location they are assigned to. Here are some recommended websites:

<https://www.ventusky.com/> - weather prediction and meteorological data visualisation

<https://weather-and-climate.com/> - you can get annual weather data for countries and cities

<https://www.wunderground.com> - you can get historical data on weather variables for cities

<http://tinyurl.com/compare2cities> - you can compare temperatures of two cities for different time periods (10 years)

They can keep track of their ideas as they explore by writing in post-it notes.

As they explore weather patterns, facilitators can ask students: Were their predictions right about the area they were assigned to in terms of amount of rain, temperatures, etc? Was temperature/precipitation/other weather variables the same throughout the year? Why or why not? What could be the reason for this? (Hopefully, activity 4 would help them think this through).

Once done, they can then finalize their findings on a new chart paper.

They can make a graph of the super-imposed variations of the weather variables in different colors. They can also make a calendar that shows the various averages for the weather variables.

After all groups are done, groups will report about findings

ACTIVITY 6: VLOGGING (ABOUT 10 MINUTES)

Groups of 3

Using their phones, students will record a vlog which they will post on Facebook.

Students will do a group vlog and post it on the Facebook page of RESET. The vlog prompt is as follows:

You will introduce yourselves. You will give Ines who lives in Sydney advice for her trip to Kuala Lumpur. Additionally, tell her why you think the weather in Sydney and Kuala Lumpur are different.

When students have posted vlogs, they would be encouraged to watch each other's vlogs and make comments about the vlogs.

FACILITATOR'S NOTE

We spent a lot of time on the word list. We were not able to do Activity 4-6.

LESSON 9: WHAT IS CLIMATE?

GOALS OF THE LESSON

- Create a short vlog to respond to Ines's question
- Draw out the idea of climate
- Have students compare climate data across climate regions

MATERIALS

- Post-it notes, different colors
- Markers, chart papers
- Word patch board
- PPT slide of the world map (with the regions marked on it)
- Map and Pictures of countries with vegetation, animals, architecture

ACTIVITIES OF THE LESSON

ACTIVITY 1: OPENING EXERCISES AND CONCLUSION TO INES' QUESTION (ABOUT 15 MINUTES)

Whole Class

Welcoming remarks given.

Share snack and remind the youth about

norms of group participation:

Speak up what you think (there is no one right answer, or we don't care if it's correct or wrong; your ideas matter)

Listen to each other carefully

Be respectful for each other

data collection through computers (ask them for help)

We are collecting data through video camera and also through computers. It will help us to evaluate the program and also allow us to keep coming here to work with you.

We will show Ines' video to remind us of what we did the previous week.

"We originally said that Sydney is going to be warmer. What was your answer after research?"

Review the group's current answer.

We will do a group vlog to send a response to Ines.

Introduce yourself. Say what you found out and advise her on what to pack.

If they can, have them post on the FB. if not, they will do at home.

ACTIVITY 2: HOW DO TEMPERATURES (OR WEATHER PATTERNS) OF DIFFERENT REGIONS DIFFER ? (ABOUT 20 MINUTES)

Group of 3 or 4 people

Transition: "So we found that the temperature for Sydney and Kuala Lumpur were different. And I wonder about other regions as well. For instance what the weather is like in February in Indianapolis? In Korea and the Philippines? We are going to think about this question throughout the session today."

In each group, we will investigate weather pattern of a city over a year. The group draws a card that contains the location, maps, and pictures of its vegetation, animals, architecture and people.

"Each set of pictures were taken from one of the regions that are marked on the world map. By looking at the map, your team will make a guess where those pictures were taken from. And talk about what the weather might be like in that area."

"What are some clues to guess the weather there?" (e.g., geographic location--they will need a map; plants and animals pics; their experiences of living there, etc.)

Encourage to think not just temperature, but the list of weather variables they came up with (e.g., precipitation, humidity, air pressure); think not just one day but patterns over a year; encourage them to use available clues; to think about factors that affect weather, that they came up with on the board.

Project the world map. Students will share their guess and reason why. Check whether they were correct or not.

ACTIVITY 3: LOOKING AT CLIMATE DATA OF PARTICULAR REGIONS (ABOUT 30 MINUTES)

Group of 3 or 4

Transition: "now, let's take a look at actual weather data."

Give them data. "We are going to analyze these data from your region. We will analyze patterns of temperature, precipitation, humidity, and wind over a year." On chart paper, they will write down their analysis. (Facilitators note: Let students explore first. If students have hard time analyzing the data, ask the specific questions written in here.)

Temperature: Is this region hot or cold?

what is the highest and lowest average temperature?

when is the hottest month and coldest month? What is the temperature in the hottest and coldest month?

Does the temperature change a lot throughout a year?

Precipitation: Does it rain a lot or not?

What is precipitation amount over a year? (they may add up.) Is the number large or not? (we may not know the answer yet, because we don't have reference point yet. But if we have some ideas from watching weather forecast etc., we can make some guess.)

Is there month(s) that the regions gets the most precipitation?

would you say it rains/snows a lot or no?

Humidity: Is this region humid or not?

What's the humidity like over a year?

Does the humidity change a lot throughout a year?

Wind: Is this region windy or not?

What do the numbers mean in the chart? What does the number mean? (Anemometer will be useful.)

What is the average wind speed like?

Are there months that are particularly windy?

Once they complete investigation, they will meet with another group and compare and contrast the weather data between the two cities.

Baghdad-Sydney

Ratnapura-Aspen

Barcelona-Nord

ACTIVITY 4: PRESENTATION (ABOUT 20 MINUTES)

Whole group

Project the world map on the board. Each pair of two groups comes out and shares weather patterns. While other groups are presenting, audience groups listen carefully and think about how those regions are different from their group's region.

Facilitators' note: These are some words to be used to describe climate.

Humid--dry/arid

temperate/mild/moderate

tropical--arctic

If time allows, have discussion about what makes the differences in the weather patterns in each region?

Students will probably say latitude and longitude. -- latitude (how far they are from the equator.)

Altitude/elevation -- how high the area is from the ground.

how close it is from water

the shape of the land, in other words whether the area is close to a huge mountain.

direction of wind and ocean current

ACTIVITY 5: WRAP UP

Next week, we will talk about weather and climate in the area that we used to live and teach other people who don't know about the region.

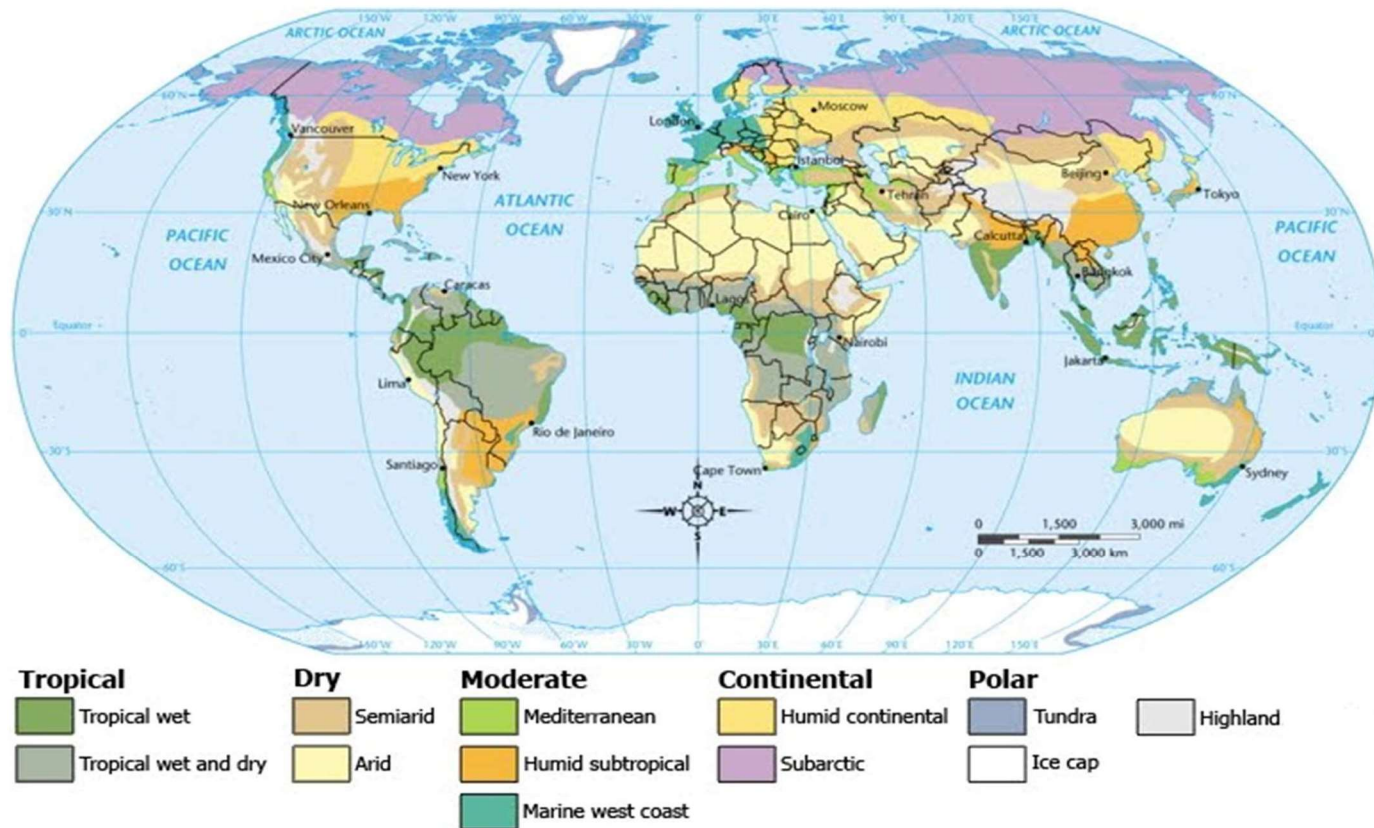
FACILITATOR'S NOTE

We had few students so each student was assigned a region.

Activity 2: Pages 43-50- will be printed off and given to each group to help them in their investigation. The pictures and labels of places in pages 51-65 are suggestions for Activity 2. You can use alternative locations for this activity. Prior to the meeting, the pictures for each indicated region are to be cut and put in separate baggies.

Activity 3: The weather data in pages 66-86 correspond to the locations used for Activity 2.

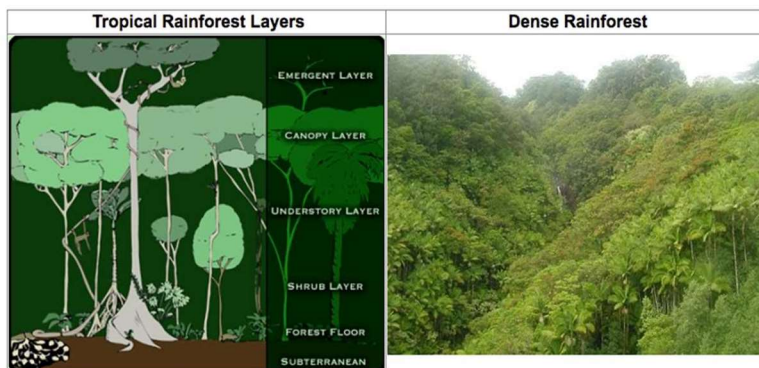
REQUIRED INFORMATION



Tropical wet

What Kinds of Vegetation (Plants) Does it Have?

The constant rain and direct sunlight at the equator allow tropical rainforests to develop. This is the only climate that can support true rainforests. Tropical rainforests only cover 6% of the Earth's surface, yet they produce 40% of the oxygen and support nearly half of all plant and animal species known to Earth. These forests are so packed full of trees they top layer (canopy layer) often blocks all sunlight from reaching the forest floor. The picture below shows the layers of a tropical rainforest.



What Kind of Animals Does it Usually Have?

Since the main vegetation is forests, monkeys are common in Tropical Wet. Snakes, frogs, birds, and small mammals are also found here. The largest group of animals are insects. Many of the animals in the rainforest are brightly colored, have tails, and unique calls (sounds)--all important survival characteristics in a thick forest.



Subarctic




What Kinds of Vegetation (Plants) Does it Have?

Not all trees are able to survive the long winters, but evergreen trees (conifers) such as pine and spruce are hardy enough to survive the cold. The forests of Subarctic climate are often called the Taiga. Taiga is the largest land biome in the world since large areas of Russian and Canada are covered in Subarctic Taiga. A biome is an area that is similar in climate and geography. Other ferns, shrubs and grasses can be found during summer months.

Conifer Needles	Conifers are found in many climates	Conifers are green in winter-- "Evergreen"
		

What Kind of Animals Does it Usually Have?

Many animals can survive the harsh climate of the Subarctic. Black and Grizzly Bears, Bald Eagles, wolves, bobcats, and wolverines are some of the animals found here. Caribou and moose are also found here. All of these animals either hibernate or migrate during the coldest months of winter. Thick fur also allows them to survive the cold winters. In the summers, mosquitoes are known to swarm in huge groups and drive people crazy.

Brown Bear	Bobcat	Mosquito Swarms
		

Tundra

What Kinds of Vegetation (Plants) Does it Have?

The permafrost (frozen soil) prevents any trees from growing here (see picture below). Many different types of mosses, lichens, and algae grow in Tundra climate. Lichens are a mixture of algae and fungus (see [Ice Cap Climate](#)). Some grasses and low shrubs can also survive.



What Kind of Animals Does it Usually Have?

The main animals found in Tundra climate are Polar Bears, Musk Ox, Arctic Fox, Snow Owl, reindeer, and lemmings. Many insects and birds also exist, especially during the summer.

Polar Bear	Musk Ox	Reindeer (Caribou)
		

Arid





What Kinds of Vegetation (Plants) Does it Have?

There are a few Arid climate areas that are so dry that no plants can survive, such as Atacama Desert. However, many Arid climate areas do receive some rain (up to 10 inches a year), so you will find vegetation in most Arid areas. To survive in this climate, plants must either require very little water or be able to store water. The plants often have long roots and thorns. Some examples are scrub bushes, grasses, and cactus.

Saguaro Cactus	Prickly Pear	Aloe Vera
		

What Kind of Animals Does it Usually Have?



Over thousands of years certain animals have adapted to the lack of water and extreme temperature to survive in an Arid climate. Camels store water in their bloodstream and can drink 40 gallons of water in 10 minutes, allowing them to go days without water. Foxes and jackals can also be found in deserts around the world. Snakes such as the Sidewinder and scorpions can also survive the Arid climate.

Sidewinder	Desert Fox	Scorpion	Camel
			

Humid Continental

What Kinds of Vegetation (Plants) Does it Have?

A wide variety of plants are found in this region. Evergreen (conifer) forests are found in the north and mixed with deciduous forests (lose leaves) as you move south. Most grasses and shrubs survive here. Some areas of Humid Continental are covered in grassland. These are sometimes called temperate grasslands. This climate is excellent for farming since it has warm summers and regular rainfall.

Mixed Forest (conifer and deciduous trees)	Temperate Grasslands (wheat field below)
	

What Kind of Animals Does it Usually Have?

A wide variety of plants often supports a wide variety of animals including bears, wolves, coyotes, deer, and other smaller mammals. Thousands of birds live in this climate region. Many of these birds migrate. Animals who live in climate regions with a large range of temperatures often migrate.

Red Squirrel (Russia)	US White-tail Deer (United States)	Coyote (United States)
		

Tropical Wet Dry

What Kinds of Vegetation (Plants) Does it Have?

The lack of regular rainfall prevents most trees from surviving in Tropical Wet and Dry. So, the most common vegetation are types grasses and shrubs with an few scattered trees. These types of plants have adapted to long periods of dry weather. The large grasslands are often called **savannas**.



What Kind of Animals Does it Usually Have?

The grasslands of Tropical Wet and Dry support many herbivores (plant eaters) who graze in the grasses. Most of these animals usually migrate and run in large herds for safety. Examples include wildebeests, gazelles, zebras, elephants, giraffes, etc. Many carnivores (meat eaters) follow and hunt the herbivores. Lions, cheetahs, hyenas, and large birds hunt the savannas of Africa.

Wildebeest



Hyena



Mediterranean

What Kinds of Vegetation (Plants) Does it Have?

Plants in Mediterranean climate must be able to survive long dry summers. Evergreens such as Pine and Cypress trees are mixed with deciduous trees such as some Oaks. Fruit trees and vines such as grapes, figs, olives, and citrus fruits grow well here. Other plants include what are called "scrub", which include small shrubs, grasses, and herbs.

Scrub



What Kind of Animals Does it Usually Have?

In order to survive here, animals must be able to live in rugged land and not depend too much on large areas of grass to graze. The natural wildlife found here include goats and sheep. These animals graze, but eat a wide variety of plants compared to cows who rely on grasses. Rabbits, jackals, and lynx can also be found here.

Lynx



Jack Rabbit



PICTURES

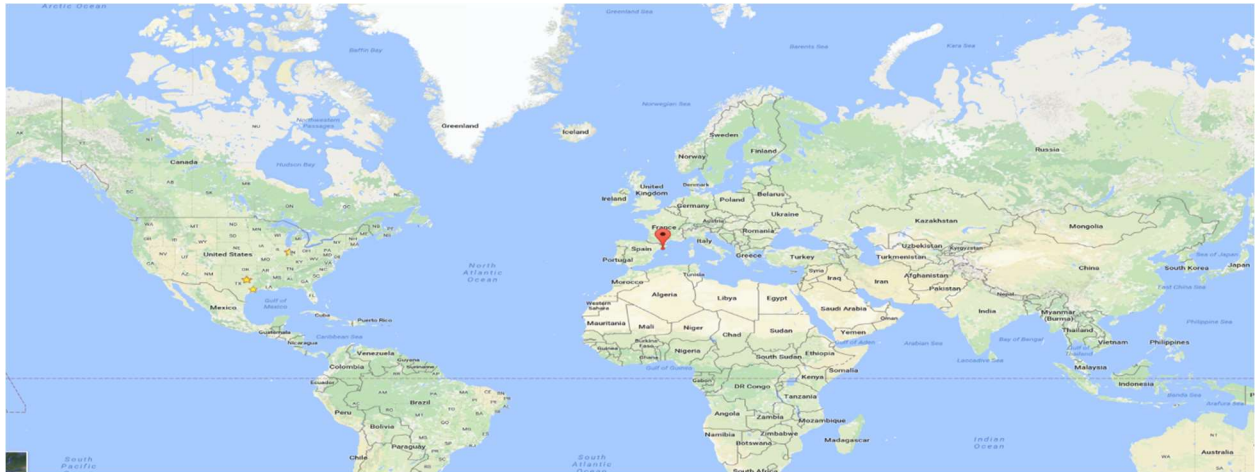
Baghdad, Iraq (Arid)







Barcelona, Spain (Mediterranean)

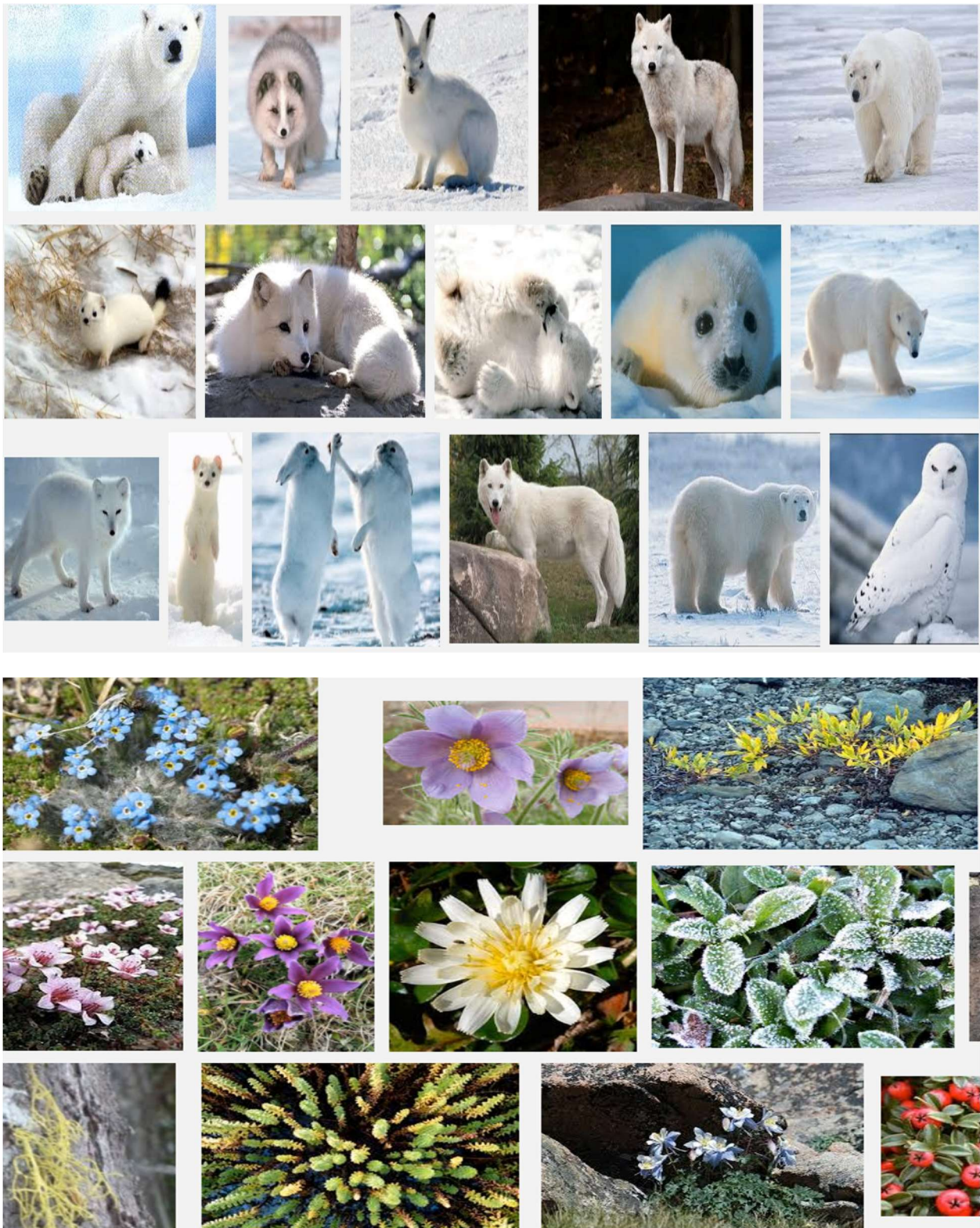






Nord, Greenland







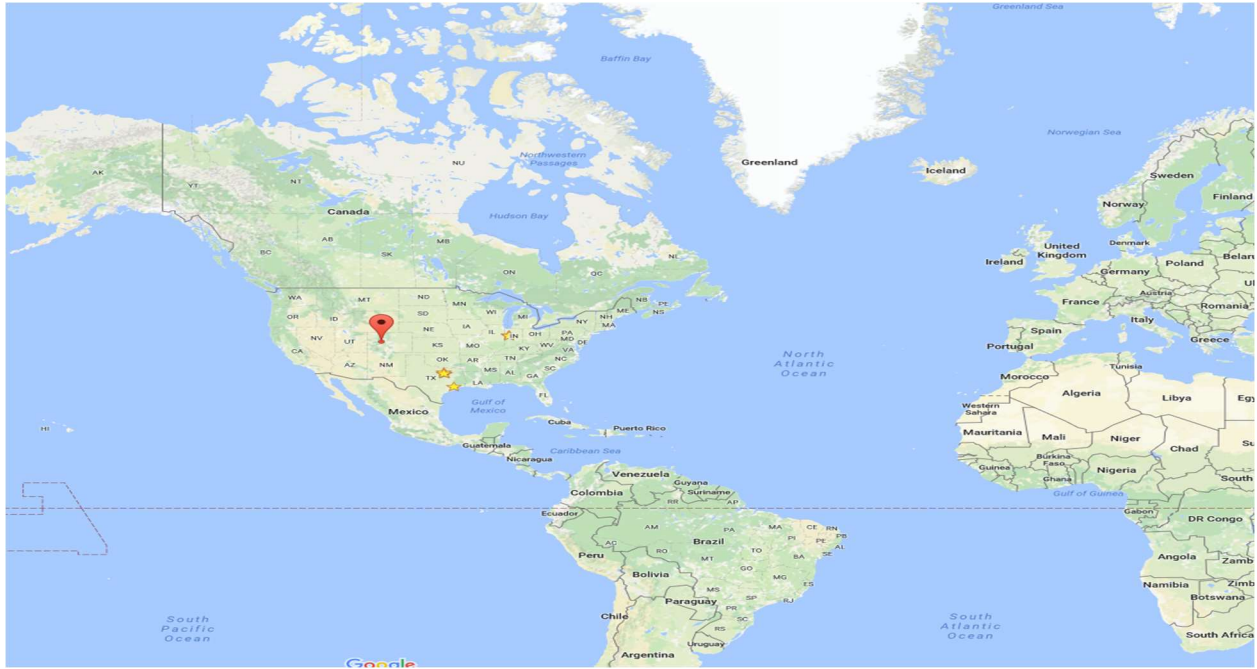
Ratnapura, Sri Lanka (Tropical Rainforest)

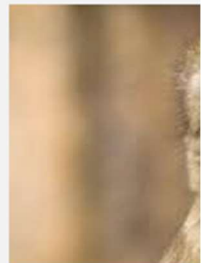
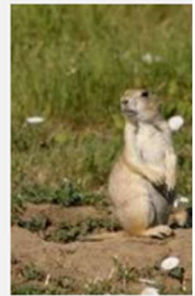
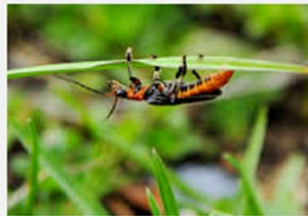






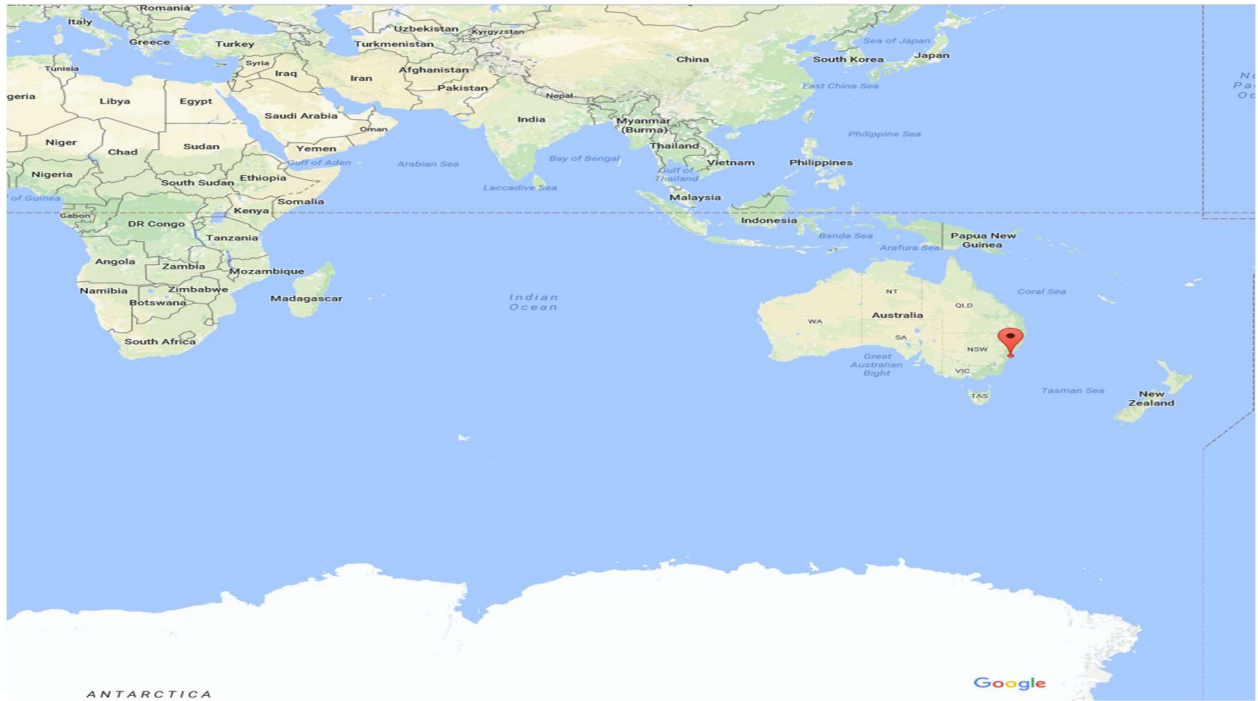
Aspen, Colorado

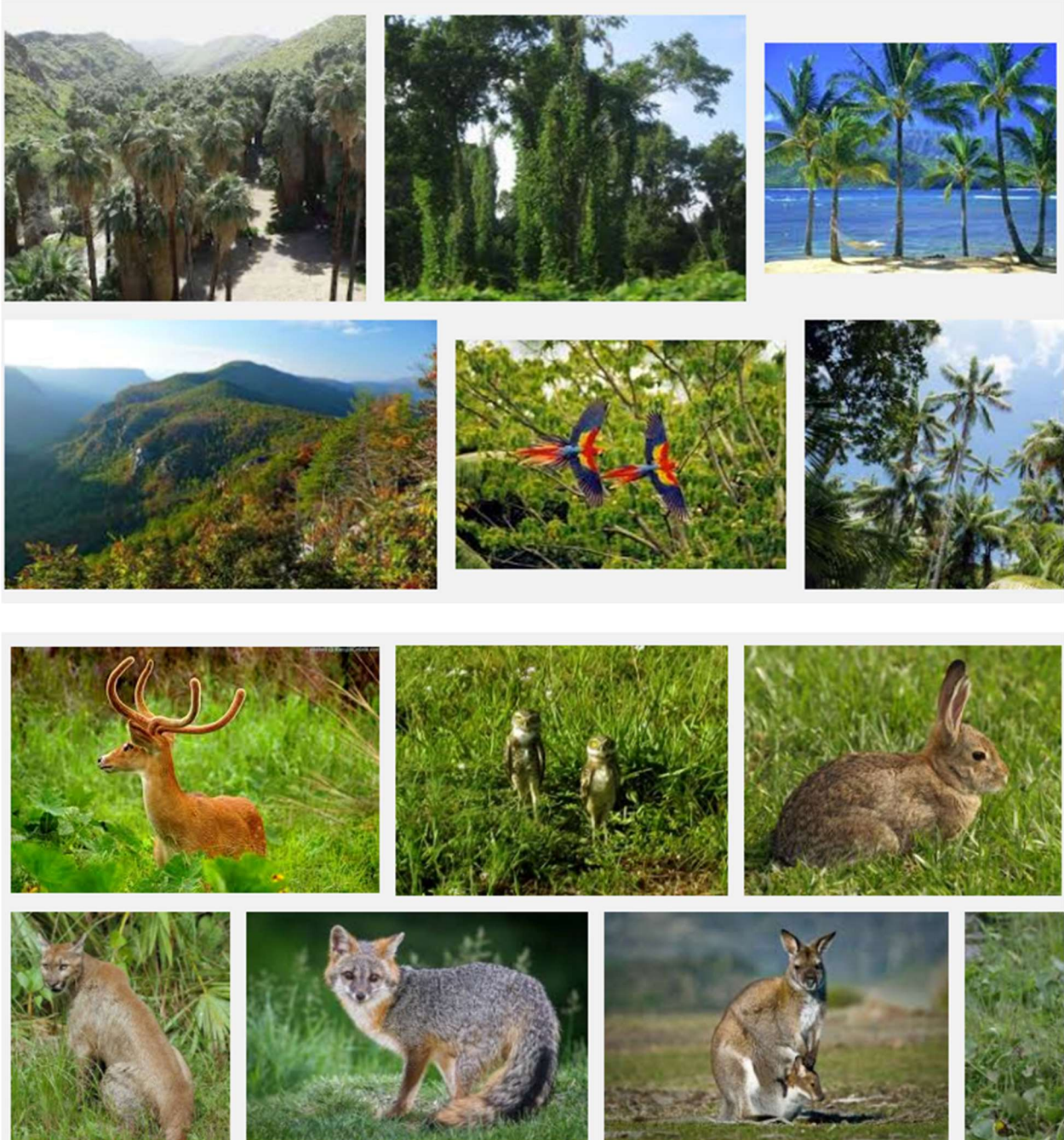






Sydney Australia (Humid Subtropical)





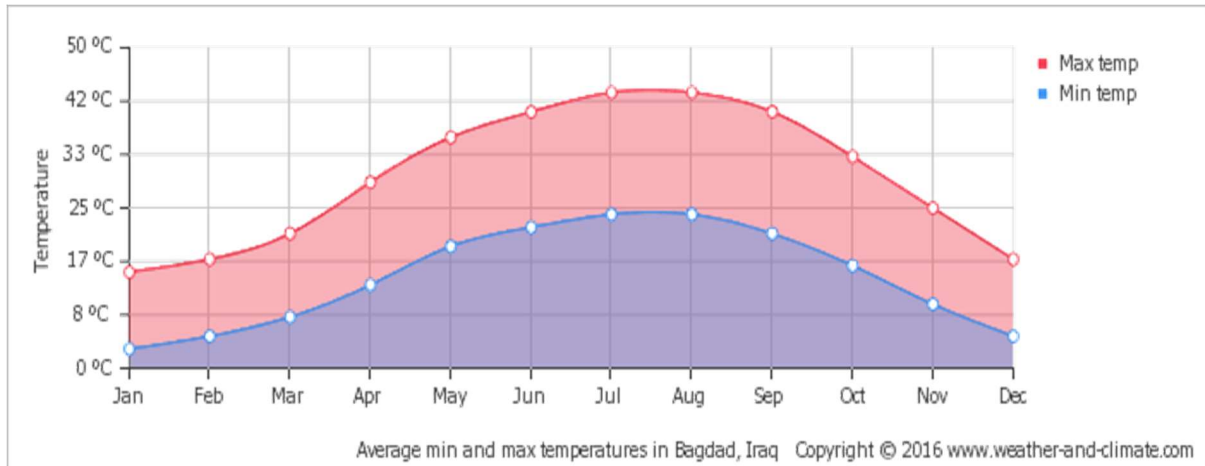


WEATHER DATA

BAGHDĀD, IRAQ

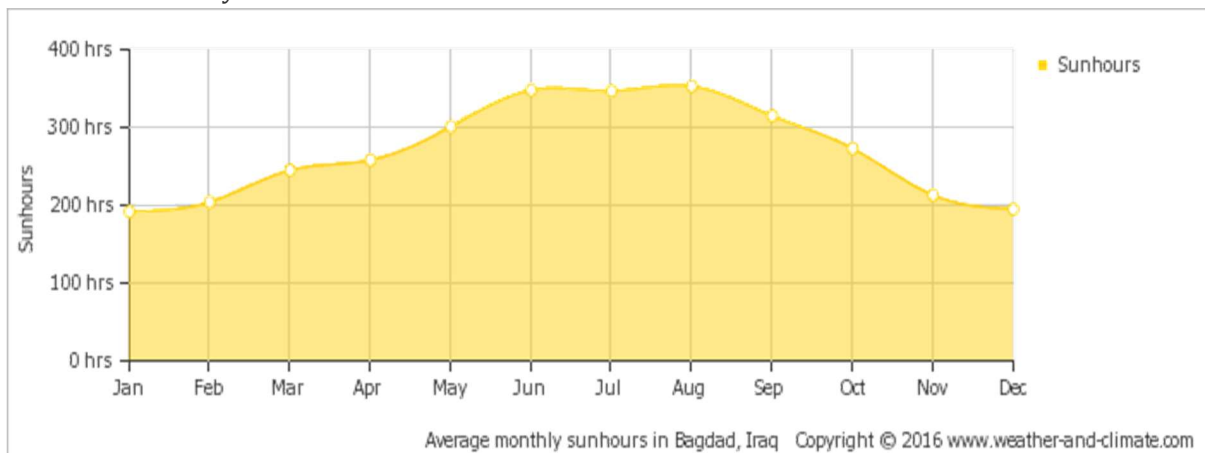
AVERAGE MINIMUM AND MAXIMUM TEMPERATURE OVER THE YEAR

The monthly mean minimum and maximum daily temperature.



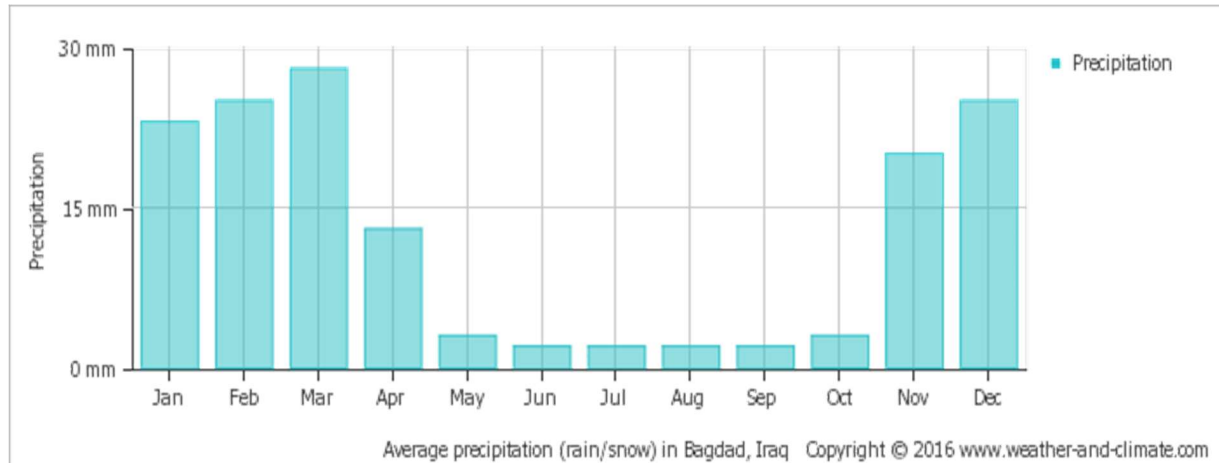
AVERAGE MONTHLY HOURS OF SUNSHINE OVER THE YEAR

This is the monthly total of sunhours



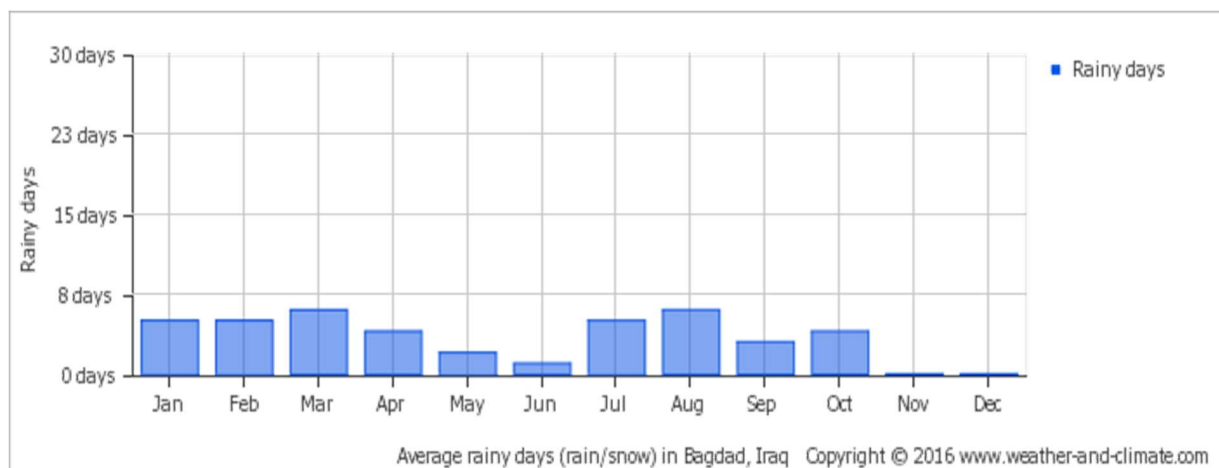
AVERAGE MONTHLY PRECIPITATION OVER THE YEAR (RAINFALL, SNOW)

This is the mean monthly precipitation, including rain, snow, hail etc.



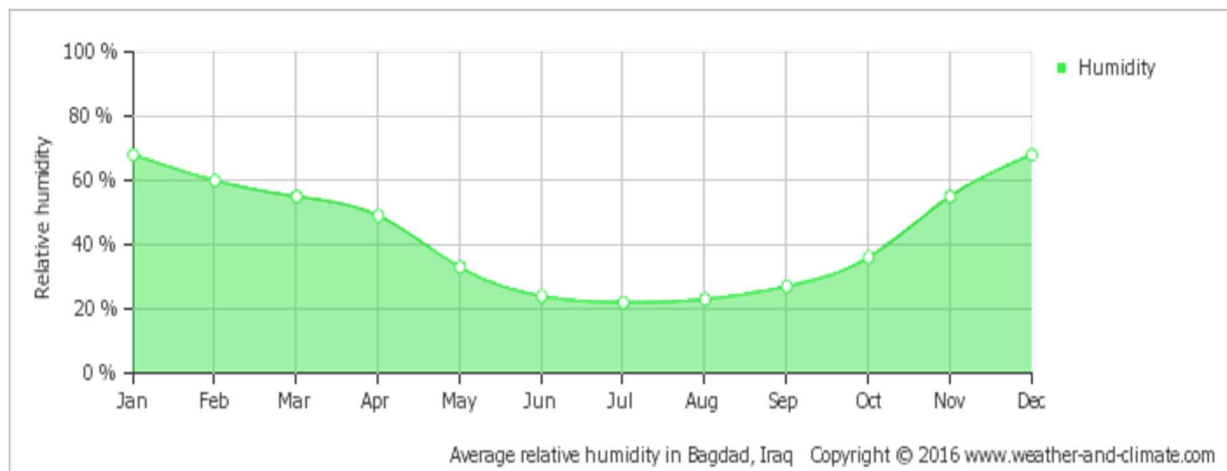
AVERAGE MONTHLY RAINY DAYS OVER THE YEAR

This is the number of days each month with rain, snow, hail etc.



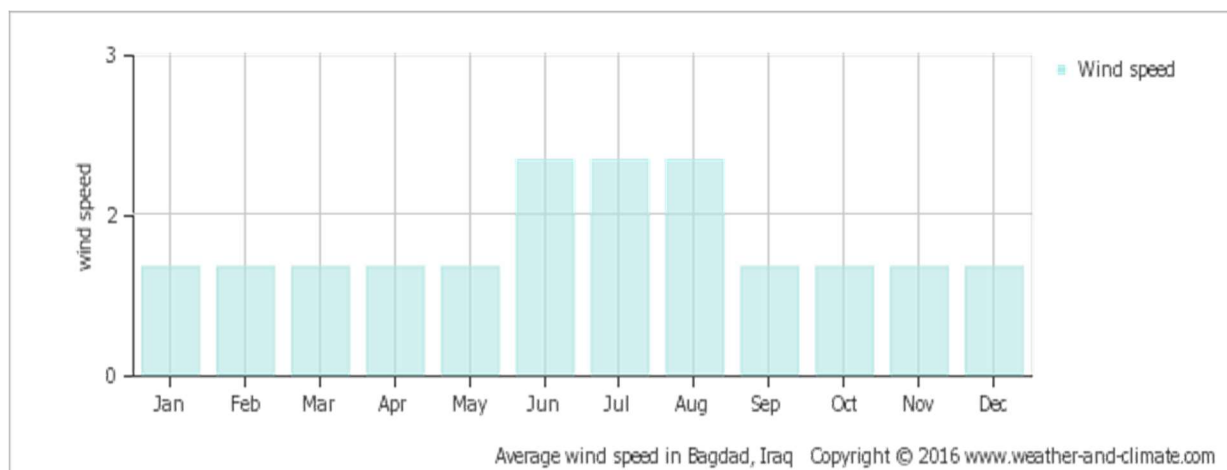
AVERAGE HUMIDITY OVER THE YEAR

This is the mean monthly relative humidity



AVERAGE WIND SPEED OVER THE YEAR

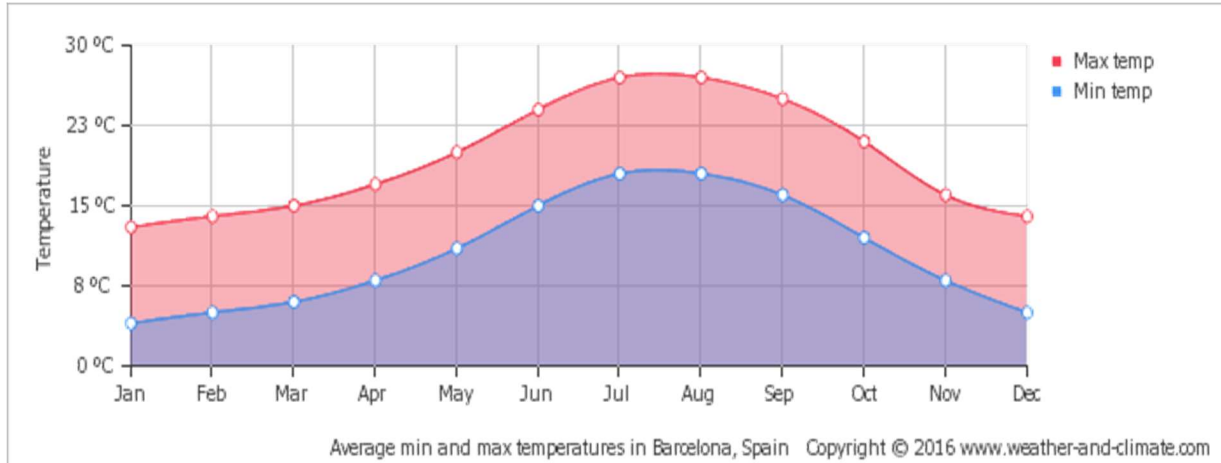
This is the mean monthly wind speed (meters per second)



BARCELONA, SPAIN

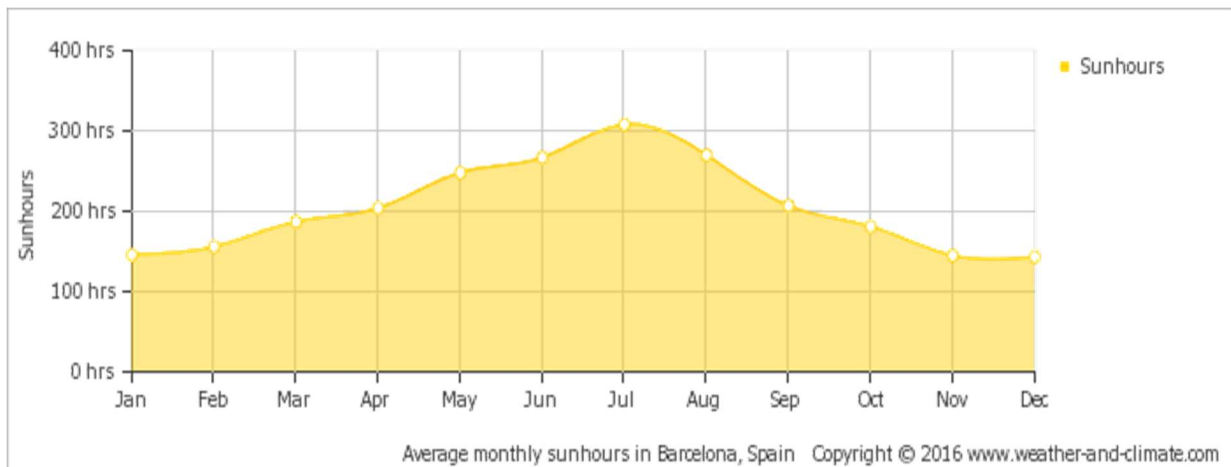
AVERAGE MINIMUM AND MAXIMUM TEMPERATURE OVER THE YEAR

The monthly mean minimum and maximum daily temperature.



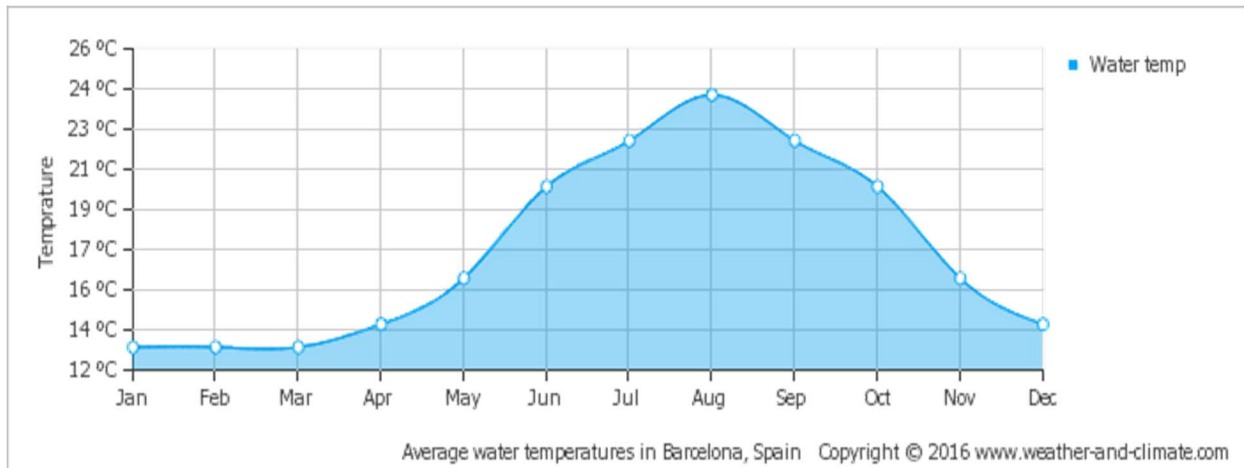
AVERAGE MONTHLY HOURS OF SUNSHINE OVER THE YEAR

This is the monthly total of sunhours



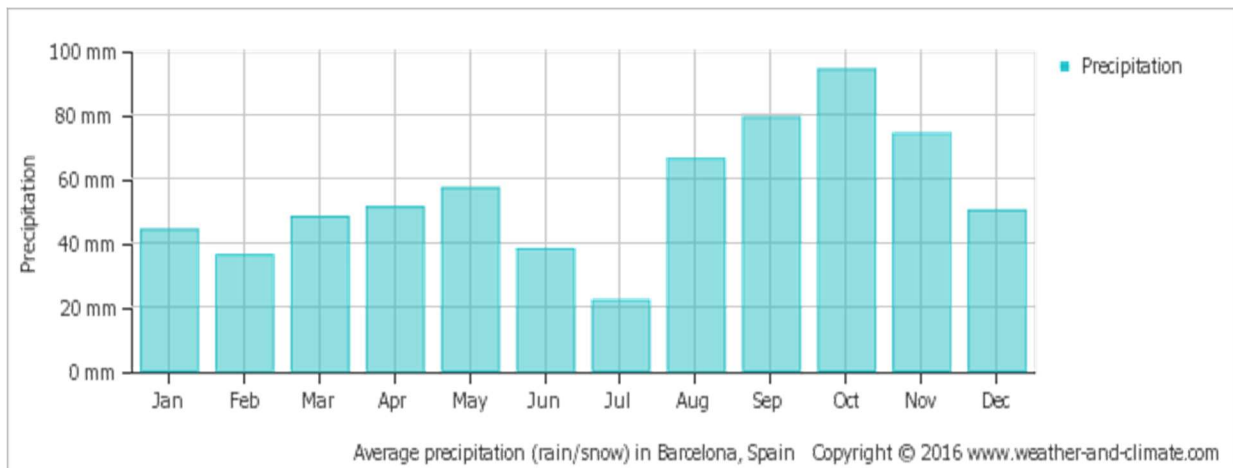
AVERAGE WATER TEMPERATURE OVER THE YEAR

The monthly mean water temperature.



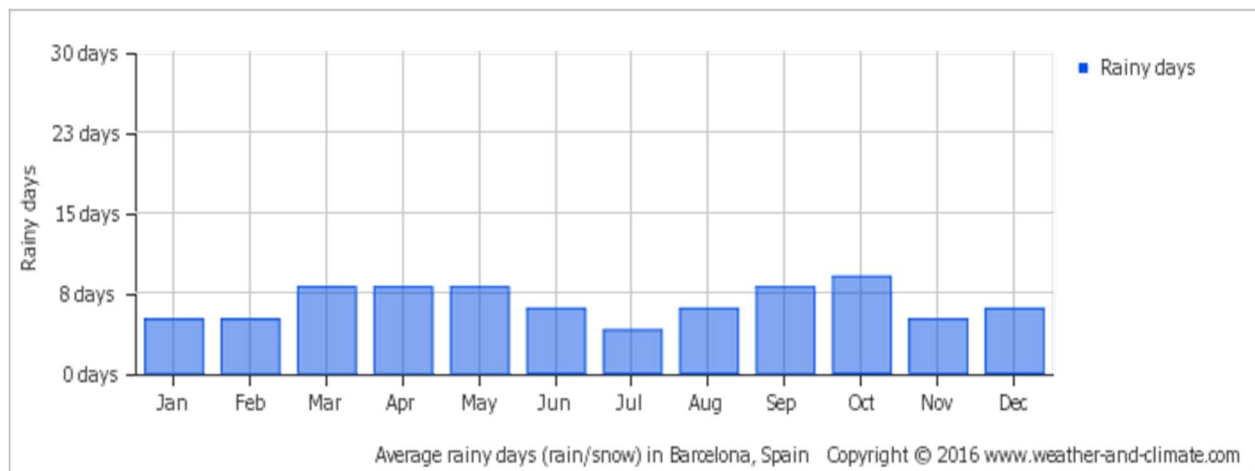
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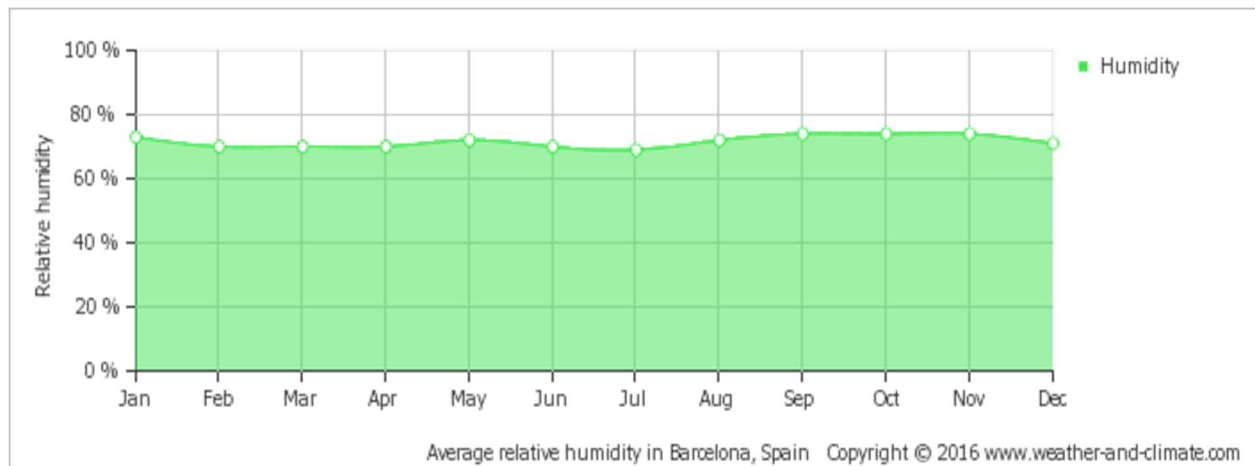
AVERAGE MONTHLY RAINY DAYS OVER THE YEAR

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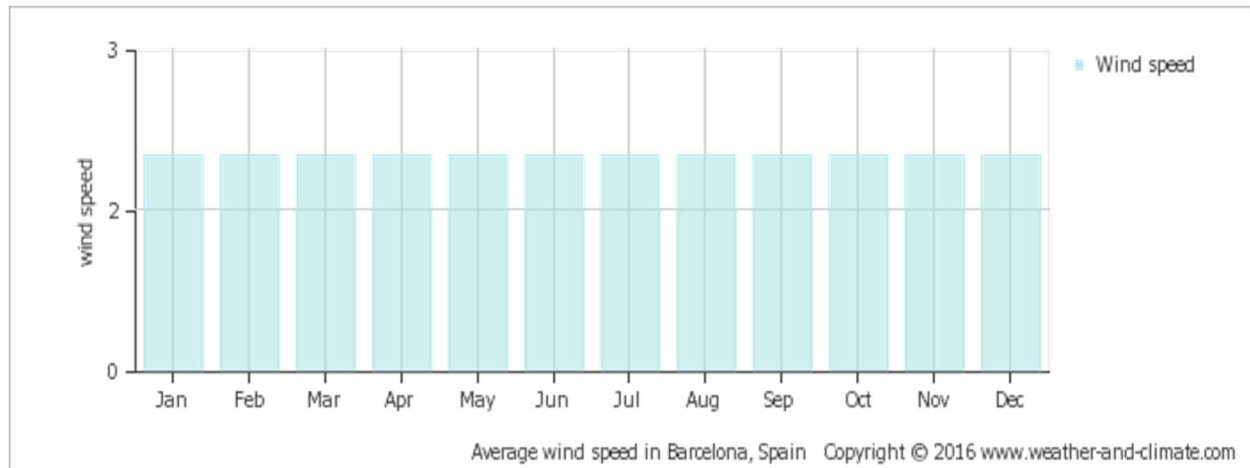
HUMIDITY OVER THE YEAR

This is the mean monthly relative humidity



AVERAGE WIND SPEED OVER THE YEAR

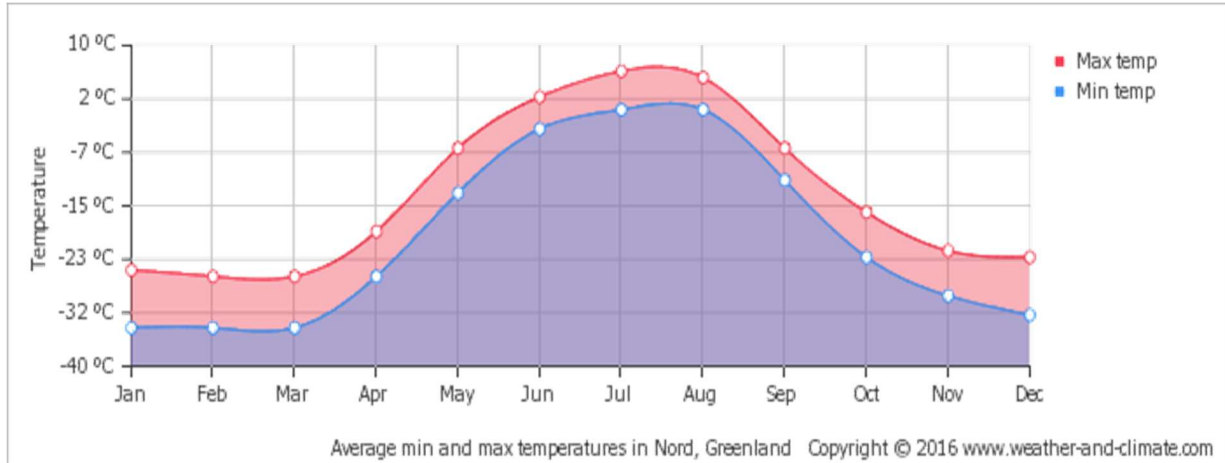
This is the mean monthly wind speed (meters per second)



NORD, GREENLAND

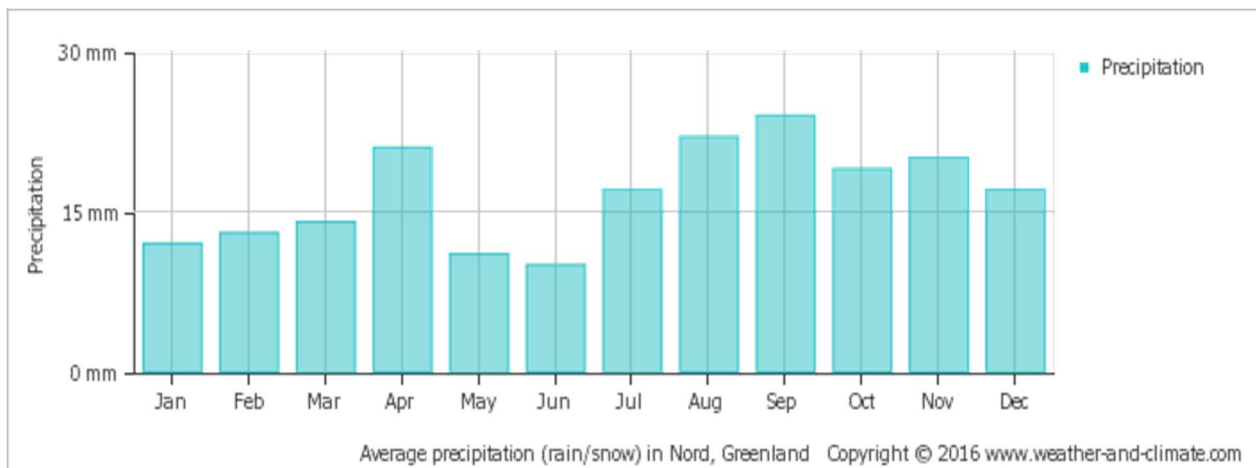
AVERAGE MINIMUM AND MAXIMUM TEMPERATURE OVER THE YEAR

The monthly mean minimum and maximum daily temperature.



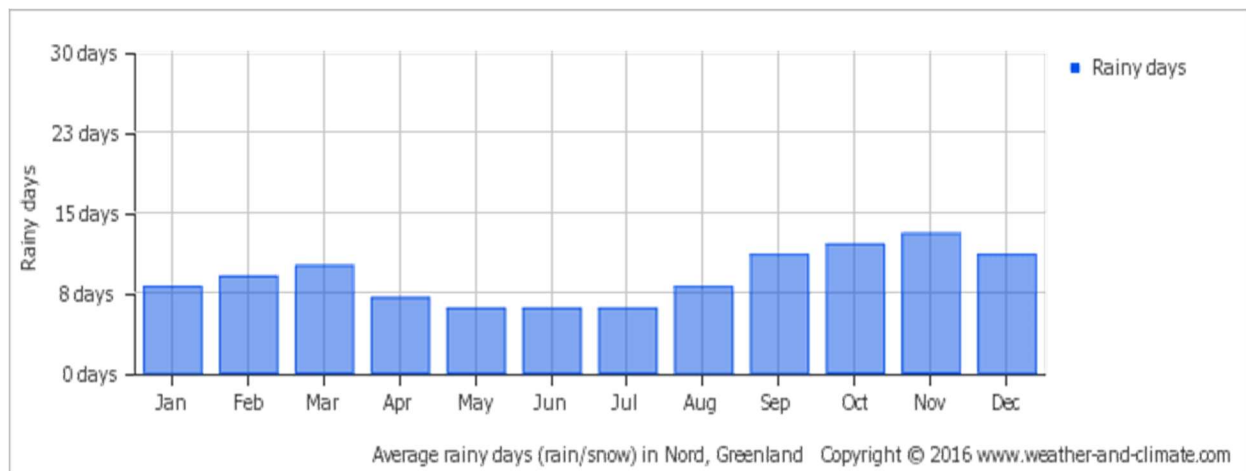
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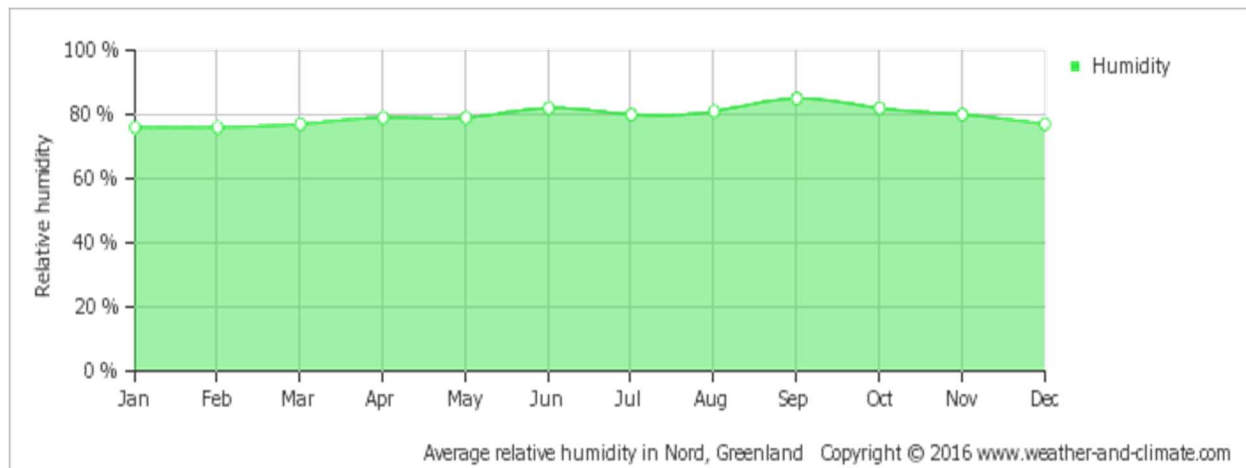
AVERAGE MONTHLY RAINY DAYS OVER THE YEAR

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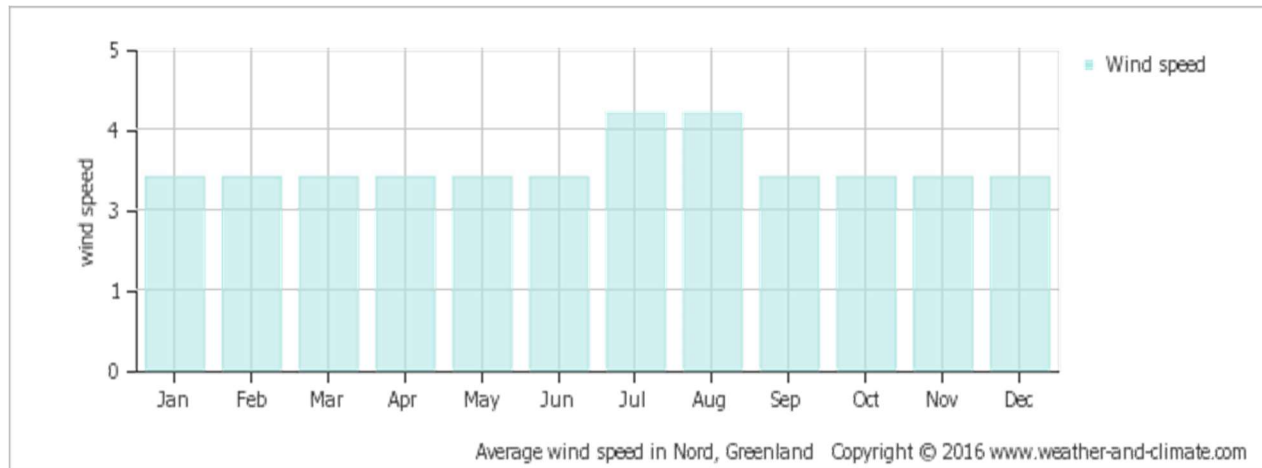
AVERAGE HUMIDITY OVER THE YEAR

This is the mean monthly relative humidity



AVERAGE WIND SPEED OVER THE YEAR

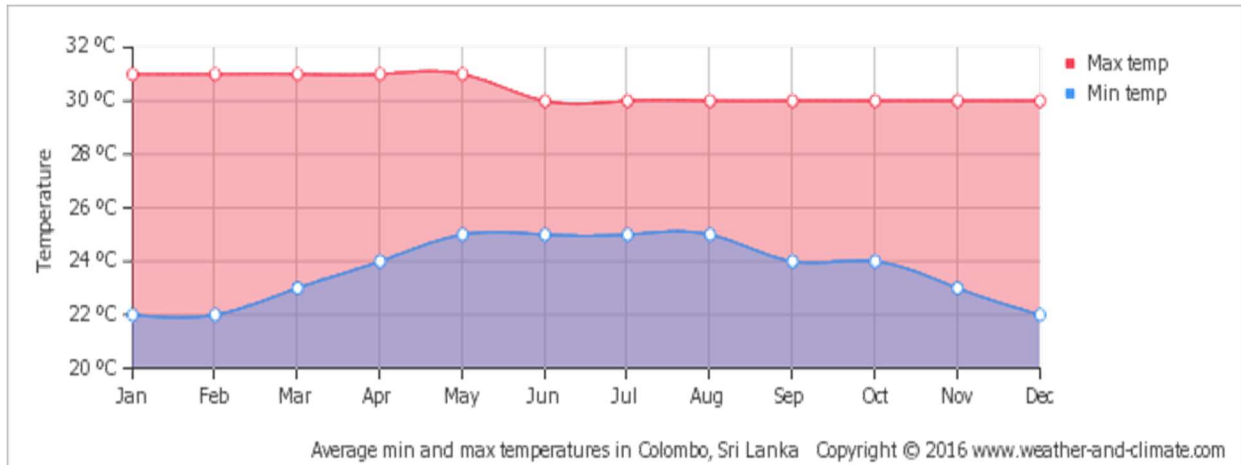
This is the mean monthly wind speed (meters per second)



RATNAPURA, SRI LANKA

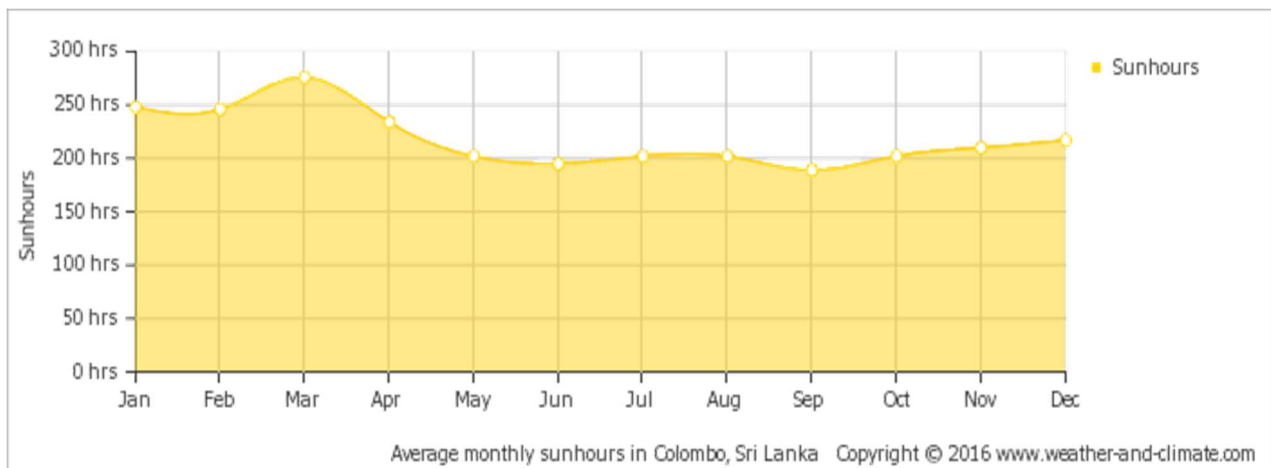
AVERAGE MINIMUM AND MAXIMUM TEMPERATURE OVER THE YEAR

The monthly mean minimum and maximum daily temperature.



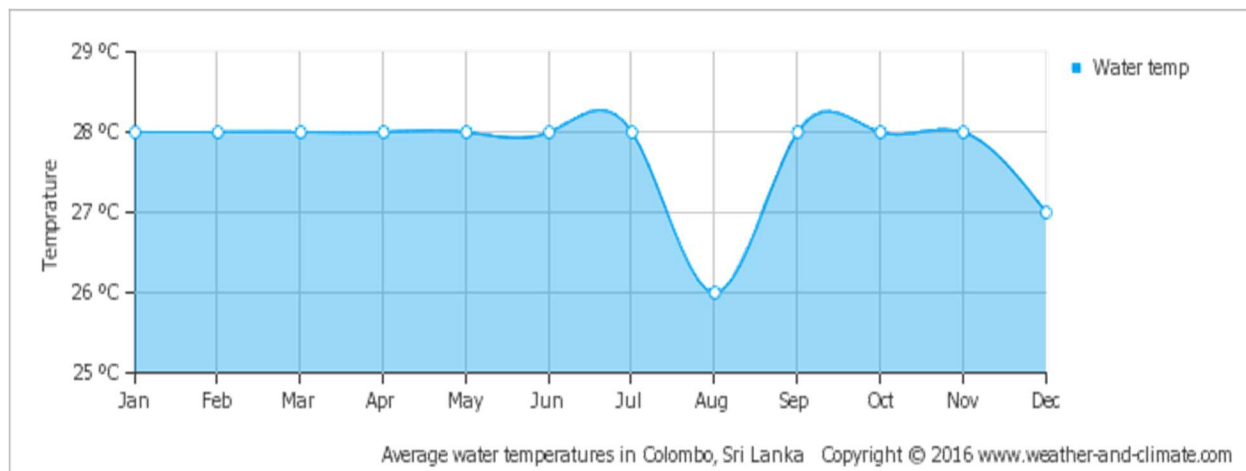
AVERAGE MONTHLY HOURS OF SUNSHINE OVER THE YEAR

This is the monthly total of sunhours



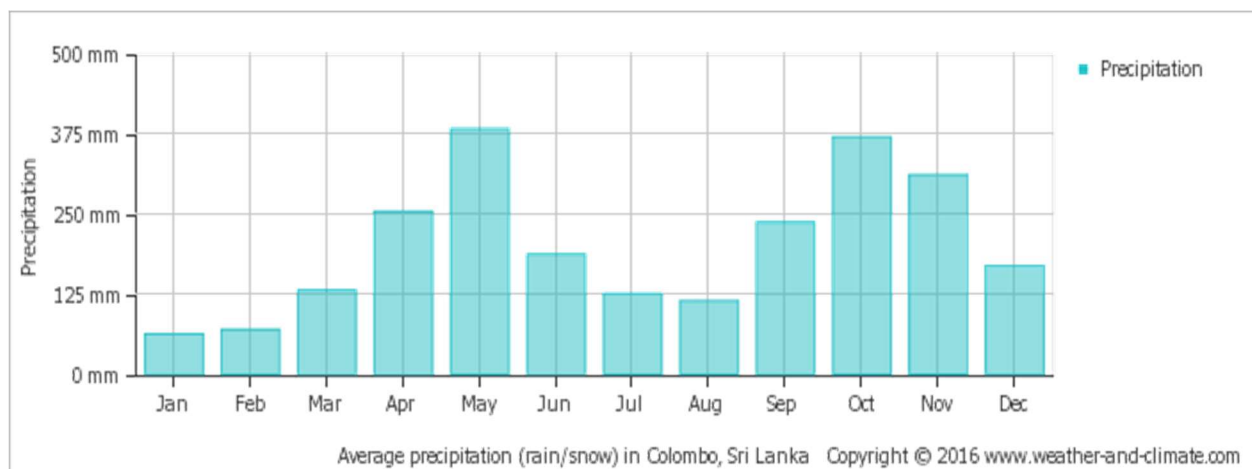
AVERAGE WATER TEMPERATURE OVER THE YEAR

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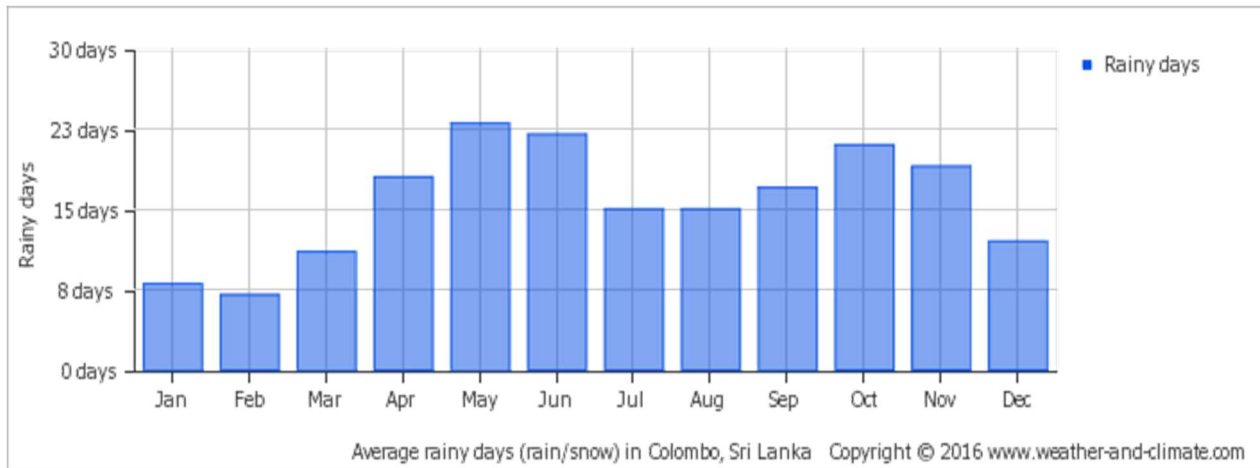
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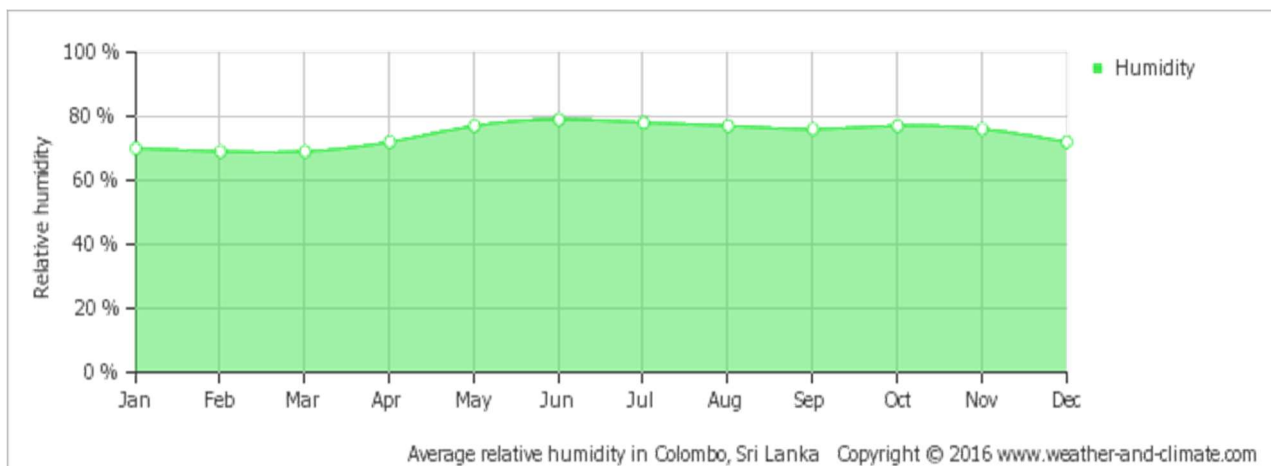
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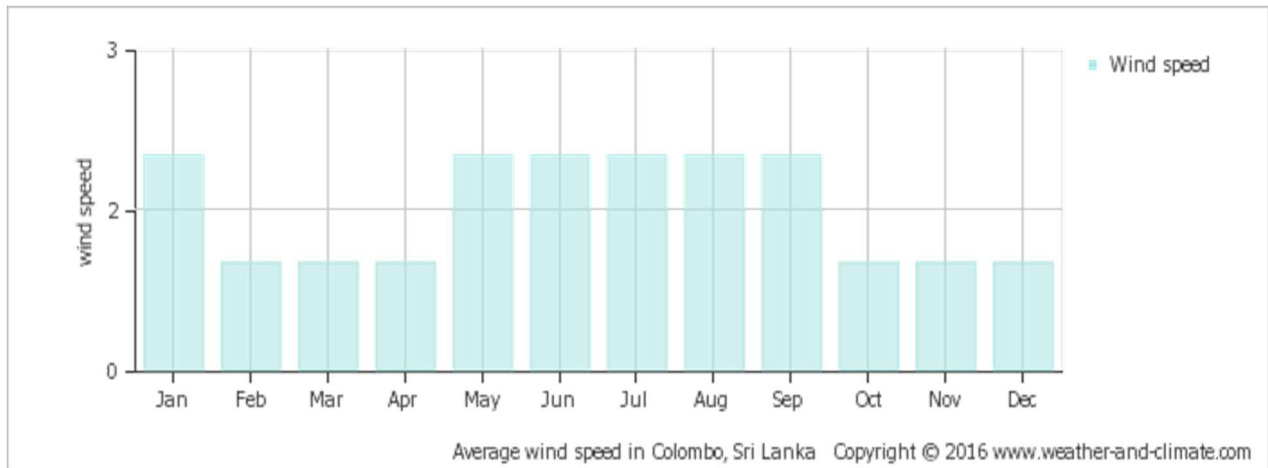
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AVERAGE WIND SPEED OVER THE YEAR

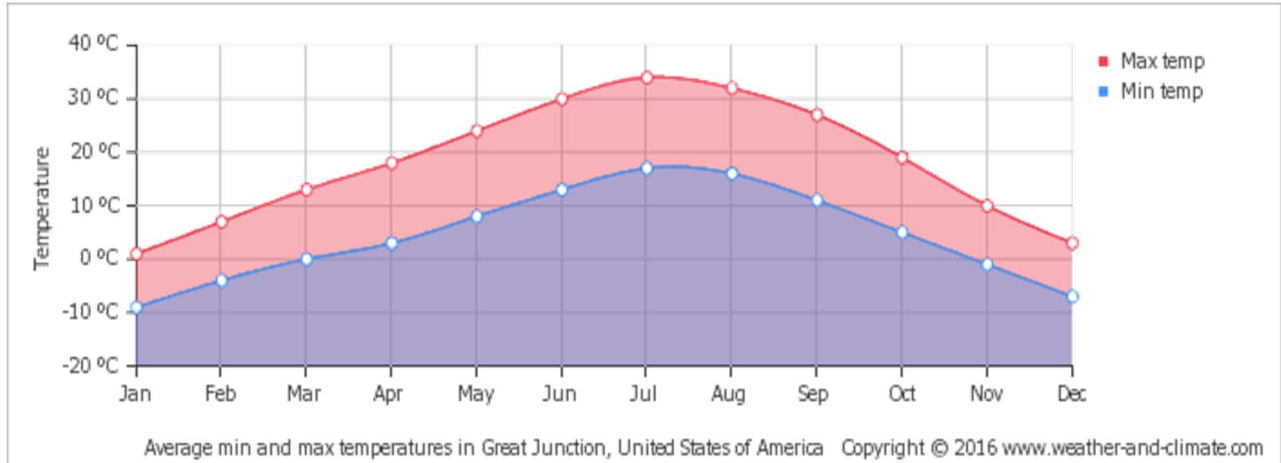
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ASPEN, UNITED STATES OF AMERICA

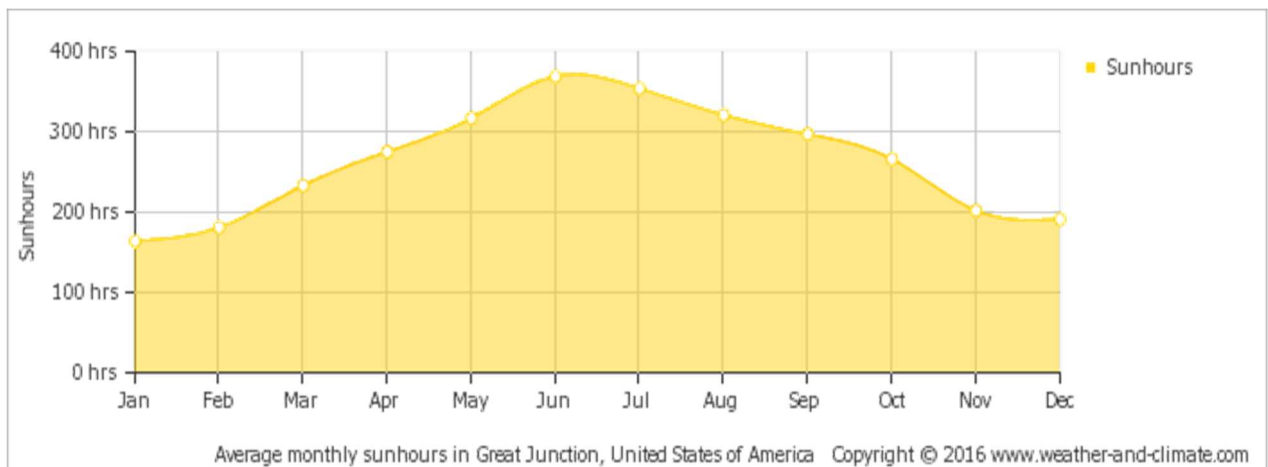
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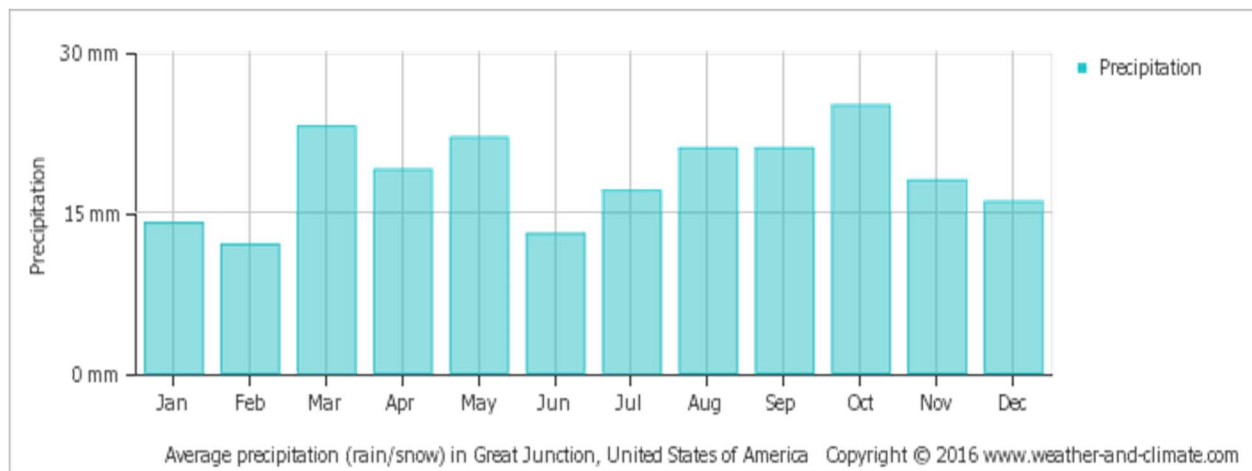
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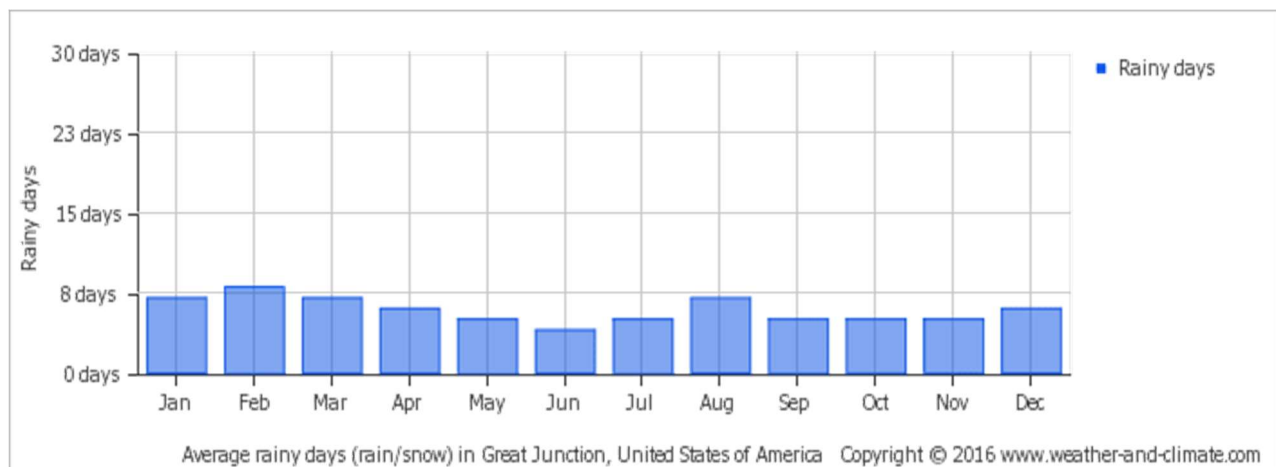
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AVERAGE MONTHLY RAINY DAYS OVER THE YEAR

This is the number of days each month with rain, snow, hail etc.



AVERAGE HUMIDITY OVER THE YEAR

This is the mean monthly relative humidity



AVERAGE WIND SPEED OVER THE YEAR

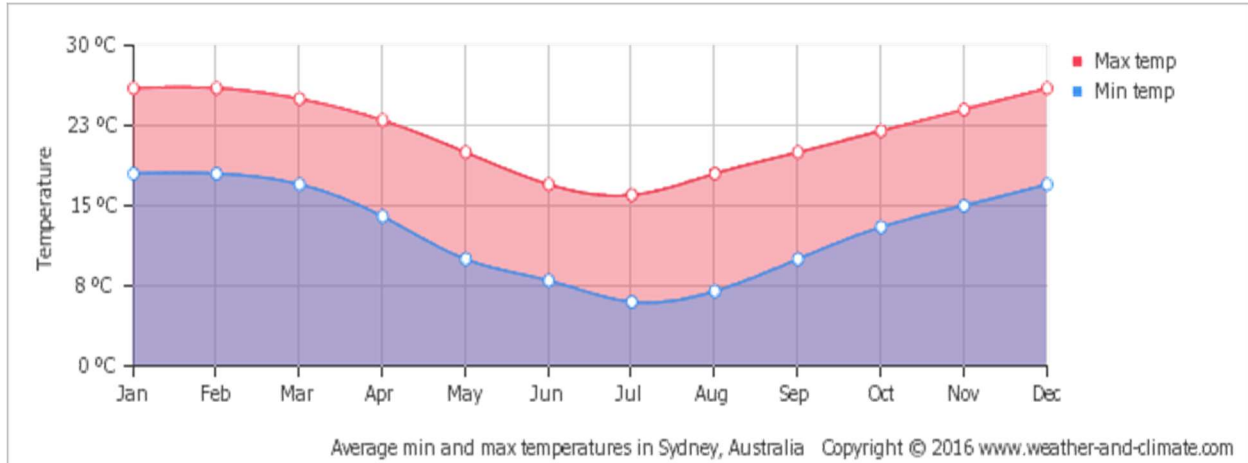
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SYDNEY, AUSTRALIA

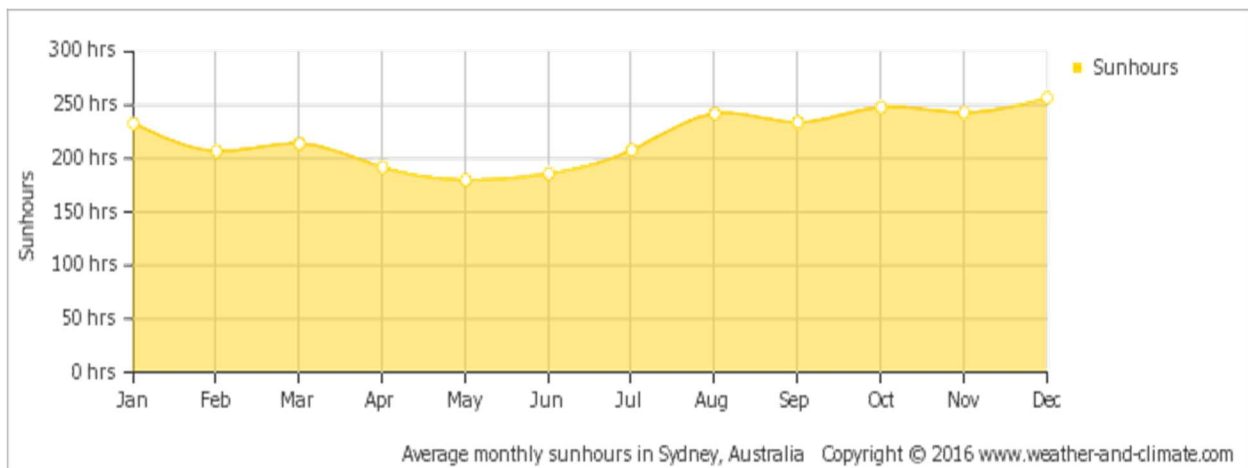
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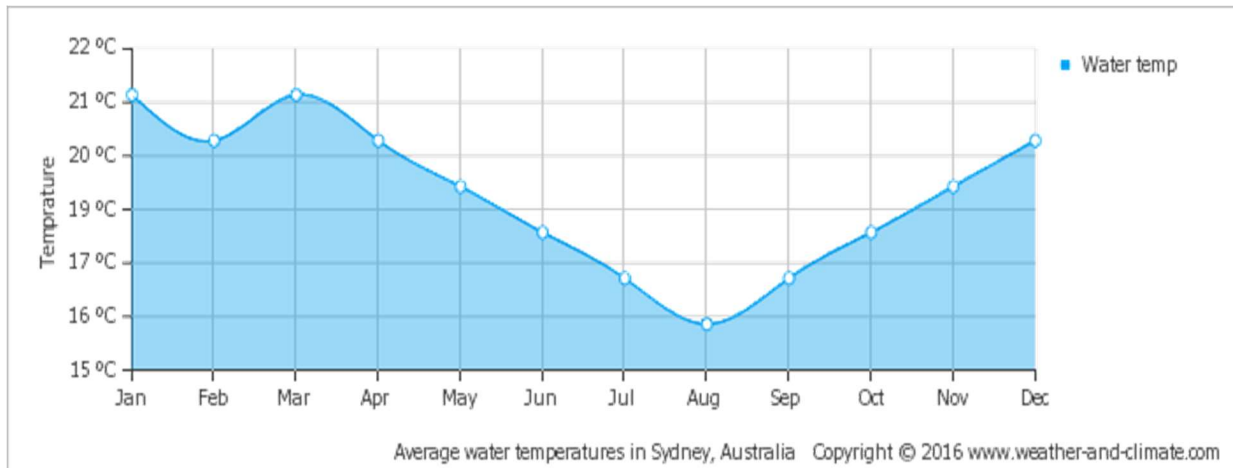
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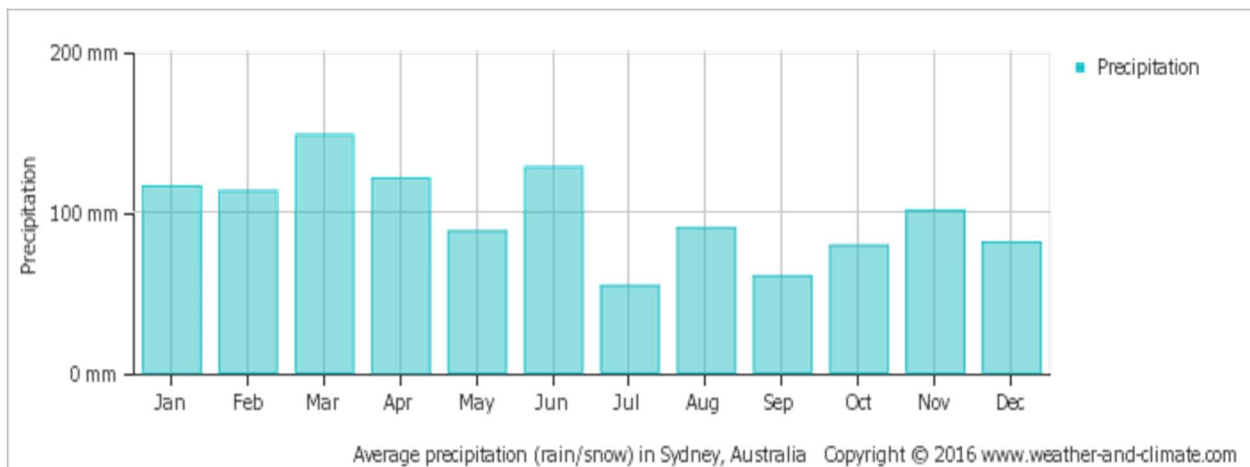
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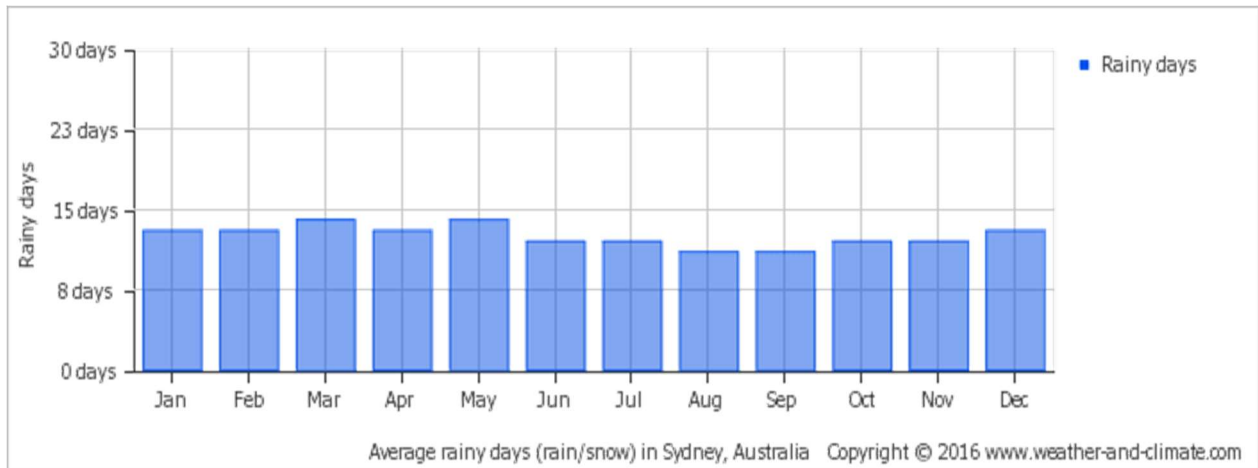
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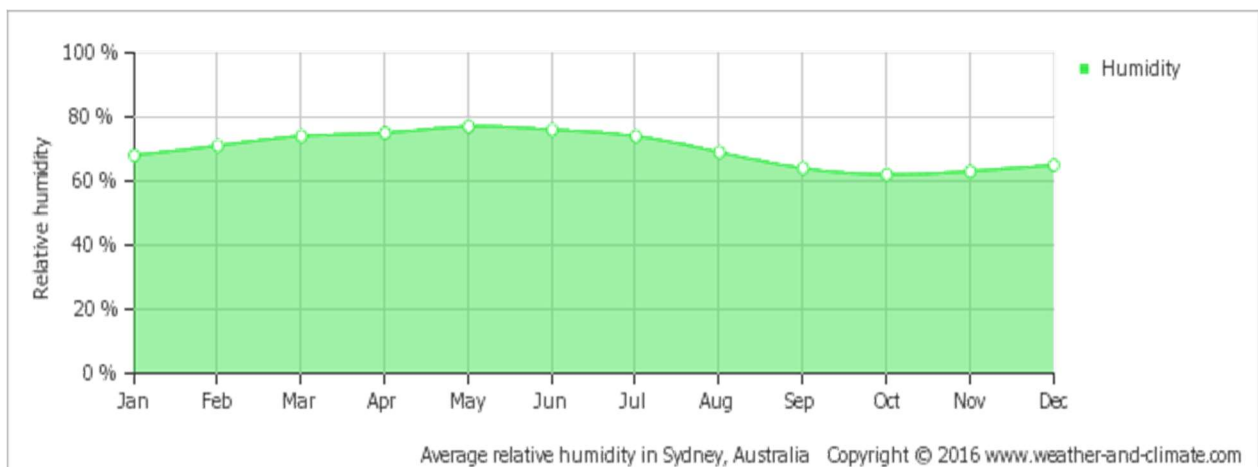
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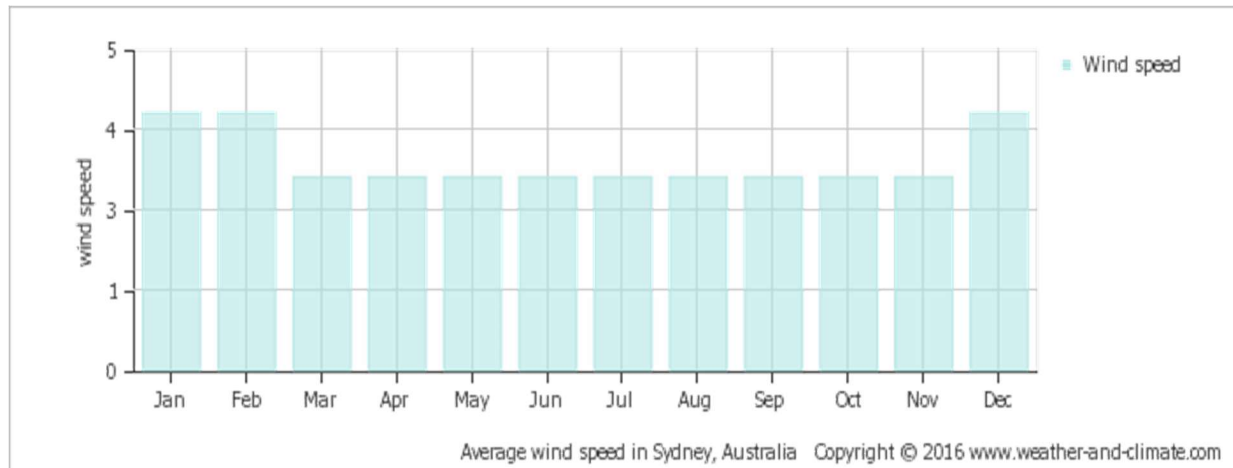
AVERAGE HUMIDITY OVER THE YEAR

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AVERAGE WIND SPEED OVER THE YEAR

This is the mean monthly wind speed (meters per second)



LESSON 10: HOW DO WE EXPERIENCE CLIMATE?

GOALS OF THE LESSON

Play jeopardy to review

Create a presentation/video that tells weather/climate story

MATERIALS

Post-it notes, different colors

Markers, chart papers

Laptops

Scissors

Tape

ACTIVITIES OF THE LESSON

ACTIVITY 1: WARM UP AND OPENING EXERCISES (ABOUT 15MINUTES)

Whole Class

Welcoming remarks given.

Play jeopardy! Divide the class into two groups. To determine who plays first, representatives will play rock-paper-scissors.

The first team chooses a category and point value. The question is given. Students must give the answer in the form of a question. The team is given 20 seconds to answer. If the team is correct, they are awarded the point value of the question. The teams take turns answering the questions. Continue until all questions have been answered. The team with the most point wins.

Prior to the meeting create a jeopardy board at jeopardy labs.com. Use the words you have discussed.

After the winners are declared, share snacks with students.

Have students who were present in the previous week talk about what we did.

ACTIVITY 2: HOW DO WE EXPERIENCE WEATHER/CLIMATE? (ABOUT 15 MINUTES)

Whole Class and Small groups

Transition: Previously, we explored different climate regions. We looked at annual weather patterns in Baghdad, Greenland, Sri Lanka, Spain, Colorado, and Sydney, Australia. Today we will explore further how we have experienced weather and climate, *how it affects us, and how*

we affect it, and also how people adjust to it. So to start, we will listen to the weather and life stories.

Vlog by Liam* , Slide Show by Shen and a MiniBook by Mavreen will be presented to tell a weather/climate story, and ask a question. The idea is for the students to have a model how to tell their story.

Discussion question: Are the stories the same/ different? Were they told the same/different? What was surprising about the stories?

ACTIVITY 3: WEATHER, CLIMATE AND OUR LIVES (ABOUT 25 MINUTES)

Individual or Pairs

Transition: You have lived in various different places and must have experienced different kinds of weather phenomena and local climate. We want to hear your stories and we would like to tell other people your stories about the places you have lived in.

You can either :

- make an 8-page mini-book of your weather story.

- make a powerpoint presentation of your weather story

ACTIVITY 4: SHARE OUT (30 MINUTES)

Students will talk about their weather/climate stories. As they share their weather/climate stories we will be taking videos of it to upload as a vlog to the FB page

ACTIVITY 5: WRAP UP (5 MINUTES)

FACILITATOR'S NOTE

The students all chose to do a powerpoint presentation. We were not able to do Activity 4 because students were still working on their presentation.

Activity 1: Prior to the meeting create a jeopardy board through jeopardy labs.

Activity 2: Prior to the meeting, vlogs, mini books, and slideshow presentation that tell weather stories should be made. Some ideas: In our implementation, Liam made a vlog about his experiences in Thailand, Shen created a powerpoint presentation about his hometown on how things are affected by the weather and Mavreen created a mini book on running in different places.

LESSON 11: HOW DOES CLIMATE IMPACT HUMAN LIFE? HOW DO WE IMPACT CLIMATE?

GOALS OF THE LESSON

Present weather/climate story

Draw what students remember the most from the program

MATERIALS

Markers, chart papers

Laptops

Worksheet

ACTIVITIES OF THE LESSON

We have two plans for this week as it depends on whether students have finished their presentations or not.

ACTIVITY 1: PRESENTATION OF WEATHER/CLIMATE STORIES (ABOUT 30 MINUTES)

Small Groups

If students finished their presentations from the previous meeting, students will talk about their stories to the class. While a group is presenting, students will be writing down 2 things they learned and 1 question they have on a worksheet.

After each group's presentation, audience will ask questions.

ACTIVITY 2: REVIEW OF THE SEMESTER? (ABOUT 15 MINUTES)

Pair & Individual

Students in pairs draw on chart paper one or two things they remember the most from the program. Then, in each side of the paper, they individually write one or two things for which they are proud of themselves while participating in the program.

Example: "I am proud of myself that this is my second year of running this program, it is going well, and I have new team members and participants who joined this work."

ACTIVITY 3: SHARE OUT (ABOUT 15 MINUTES)

Whole Class

Students will share what they did in Activity 2.

Alternatively, if students haven't done their weather stories...

ALTERNATIVE ACTIVITY 1: PREPARATION OF WEATHER/CLIMATE STORIES (ABOUT 20 MINUTES)

Small Groups

If students have not finished their presentations from the previous meeting, students will continue to work on them.

ALTERNATIVE ACTIVITY 2: PRESENTATION OF WEATHER/CLIMATE STORIES (ABOUT 30 MINUTES)

Small Groups

Students will talk about their stories to the class. As they talk about it, we will make a vlog about it.

ALTERNATIVE ACTIVITY 3: OF ALL THE THINGS THAT WE DID, WHAT WAS IT THAT IMPACTED YOU THE MOST? (ABOUT 10 MINUTES)

Pairs & Individual

Students individually write one or two things for which they are proud of themselves while participating in the STEM Program.

Example: "I am proud of myself that this is my second year of running this program, it is going well, and I have new team members and participants who joined this work."

ALTERNATIVE ACTIVITY 4: SHARE OUT (ABOUT 10 MINUTES)

Whole Class

We will form a circle and talk about the things that impacted us the most about the program. We can also share : 1 thing that we liked about the program, 1 thing that we think we should keep doing in the program, 1 thing we should start doing in the program, 1 thing we expect from the program, 1 thing we expect from ourselves in the program.

CLOSING ACTIVITY (START AT THE LATEST 7:40; FOR 20 MINUTES): ANNOUNCEMENT FOR THE SPRING SEMESTER & EAT

Whole Class

We are going to learn and talk about climate change and global warming.

Then, you will do a small research and create a video to present your research to other people.

You will be given more leadership on how you want to conduct your research and create your video. Participants last year enjoyed the video production project a lot--you learn how to tell a

story, video production skills, and also you will be able to actually tell people about what you believe is important. These are all skills you will need in college and as an adult.

WORKSHEET

Group Members	Places They Talked About	Two things you learned from the presentation	One question about the presentation

WEEK 12: RESET KICKOFF

GOALS

Draw out what students/facilitators gain from RESET

Come up with ideas for RESET activities

Draw out weather and climate topics that interest students

MATERIALS

Markers, chart papers

Post-its

ACTIVITIES OF THE LESSON

ACTIVITY 1: OPENING EXERCISES (ABOUT 5 MINUTES)

Whole Class

We welcome students to RESET Spring Semester and preview the activities for the evening.

ACTIVITY 2: WHAT IS RESET TO ME? (ABOUT 20 MINUTES)

Whole Class

Chart papers bearing the questions : 1) *What are the things I gain in the STEM Program (RESET) ?* 2) *What activities do I want to do in RESET?* 3) *What weather or climate topics do I want to talk about in RESET?* will be posted on the board.

Facilitators and students will use post-its and pens/pencils/markers to answer the questions.

Discussion follows.

ACTIVITY 3: WHAT ARE THE THINGS WE GAIN IN RESET? (ABOUT 15 MINUTES)

Whole Class

Slide bearing what facilitators think that students gain in RESET will be shown and talked about. Then we will ask students to use post-its and markers to write down what they think they can gain in RESET.

Facilitators will also talk about the plan for spring semester : 1) learn about climate and climate change, 2) a field trip in March, 3) video making.

Facilitator will talk about some exciting things students will get at the end of the year: 1) We will go to the field trip in late February or March at NWS. 2) For spring attendance 70% and

higher you get a certificate at the end of the year. 3) For fall and spring attendance 70% or higher, you get a XXXX.

ACTIVITY 4: LET'S WATCH SOME VIDEOS! (ABOUT 10 MINUTES)

Whole Class

Videos from last year will be shown to students as they eat their snacks to give them an idea of what we envision for the video. We should also offer other options for video making (maybe a short film, an infomercial, etc)

ACTIVITY 5: WRAP UP

LESSON 13: ARE EXTREME WEATHER EVENTS DUE TO CLIMATE CHANGE?

GOALS

Draw out student ideas of weather and climate

Draw out what students know about climate change

Evaluate extreme weather events as possible evidence of climate change

Make connections between extreme weather events and climate change

MATERIALS

Readings (Heat waves and Droughts, Melting ice, Warming Oceans)

Videos on Extreme Weather Events

Work sheet for WK 13 Reading

Chart paper, Easel, Markers

ACTIVITIES OF THE LESSON

ACTIVITY 1: EXTREME WEATHER EVENTS (ABOUT 30 MINUTES)

Pairs & Whole Class

Introduce the goal of today: Extreme weather events and their relation to climate change. Facilitator asks the class “What are some extreme weather events that you’ve experienced/ seen in the news/ or heard about?”. Students will talk about extreme weather events that they have experienced for about 5 minutes and share them out in the whole class. There can be some experiences in Burma and Malaysia.

Then say, “This evening we will be watching a couple of short videos of extreme weather events that we may not have experienced”.

Show the videos:

Worst Drought in 30 years Hits South Africa (2:36)

<https://www.youtube.com/watch?v=-GbQWmFzVdY>

Record Heat Wave Scorches India (2:01)

https://www.youtube.com/watch?v=E0y_l79lWpc

Typhoon Haiyan: Why it’s one of the most powerful on record (2:56)

<https://www.youtube.com/watch?v=jx7Ni6CoiUo>

Facilitator asks to summarize what the videos were about. "What parts of the world and the U.S. are suffering from drought, heatwave, and severe storms?"

There are people who believe that these extreme weather events are part of climate change. Then pose and write the main question on the board: Are extreme weather events indicators of climate change? Or are these just "naturally-occurring"? How would we know if they are or they are not? Ask students for their ideas.

Say that we are going to be talking about climate and climate change this semester and for this evening our main goal is to evaluate whether extreme weather events are indicators of climate change. This would also serve as a transition for the next activity.

ACTIVITY 2: WHICH IS THE MOST CONVINCING EVIDENCE? (READING: ABOUT 20 MINUTES; SHARING: ABOUT 20 MINUTES)

Small Groups

Introduce three reading materials. We have three sets of articles to discuss three larger sets of evidence for climate change. Check on students' understanding of the titles.

Heatwaves and droughts (What is a drought?? Elicit and then say explicitly, briefly)

Melting ice in glaciers and icebergs (Elicit, tell, or show picture of these 2 terms so sts are comfortable.)

Warming ocean

Given as much as you know about climate change, which one do you think is most convincing evidence of climate change? Of these 3, which do you think is the most convincing or important evidence? Why?"

To attempt to answer the main question for the evening, we will now break up into small groups and discuss 3 extreme weather events. Students will count off number and receive a reading material based on their number. We will do our reading "jigsaw style" - wherein *each member of the group would be given a different reading material* - heat waves & droughts, melting ice and warming ocean. The idea is that at the end of the readings, the small groups will come together to discuss the different topics.

Group members who have heat waves & droughts will get together to take turns reading and discussing ideas. Different reading groups will also be formed for melting ice and warming ocean. Together, they will identify three pieces of evidence from their reading. They have to explain why the chosen evidence supports climate change is occurring. Discuss: Which type of evidence within your article is the most convincing evidence of climate change? Why do you think so? Co-facilitators should facilitate the reading/discussions within the reading group.

After the reading, the small groups will once again get together. Say “ Since group members read different articles, you will now tell each other about the most convincing evidences from your article. Listen to each other and talk to each other. Then discuss and rank the evidences across articles in the order of the most convincing to the least convincing. Include at least 3 ideas in your list” Each group will now have nine different pieces of evidence.

Students will then be given markers and poster paper. They will write their lists on the poster paper.

ACTIVITY 4 : VLOGGING (ABOUT 20 MINUTES)

Small Groups

In small groups, students will make a vlog on the the main question : Are extreme weather events due to climate change? They will talk about the 3 most convincing pieces of evidence that came up from their small group discussions.

If there is time, we will then discuss the evidences that were deemed most important.

What kind of consensus do we see?

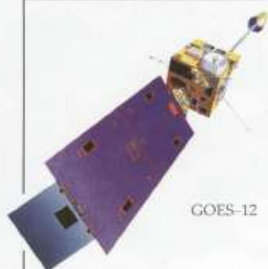
Are there evidences we would like to explore more? Why?

Were there ideas from the readings that do not seem connected to climate change?
Why?

ACTIVITY 5: WRAP UP

FACILITATOR’S NOTE

We were unable to do Activity 4.



GOES-12

WEATHER SATELLITE
Launched in July 2001, the GOES-12 environmental satellite is one of many orbiting spacecraft equipped with remote sensors for monitoring weather conditions in the lower atmosphere, 22,370 miles (36,000 km) below the satellite.

Heatwaves and droughts

BY STUDYING WEATHER AND CLIMATE DATA gathered from all over the world, and transmitted from orbiting satellites, scientists can compare it with past records to work out how much the world has warmed up. But for many people, the evidence of climate change is much more obvious. They are suffering heatwaves that can raise temperatures to lethal levels, and living with droughts that make drinking water scarce, kill their crops and farm animals, and turn fertile land to desert. Some of the droughts may be caused by natural cycles, and deserts can be partly created by poor farming methods such as overgrazing by livestock. But there is little doubt that periods of seriously hot or dry weather are getting more frequent.



HEATWAVES

Higher extreme temperatures are becoming more common. They are not always the highest daytime temperatures known since records began, but long periods of sustained high temperatures known as heatwaves. During the European heatwave of August 2003, Paris suffered nine days in a row with temperatures above 95°F (35°C). Aug 10 of that year was the hottest day ever recorded in London, peaking at 100.6°F (38.1°C), and 117.1°F (47.3°C) was recorded at Amareleja in Portugal. Here a fountain in Prague helps a woman cool down during a heatwave that hit the Czech Republic in July 2007.



THE HUMAN TOLL

Heat can be a killer, especially when it continues through the day and night. In the U.S. people cope with heat by using air conditioning—which itself contributes to climate change. In regions where people are not equipped to deal with the heat, they are more vulnerable. The elderly are the first to suffer, like this victim of a heatwave in Chicago in 2006, because their bodies cannot lose heat easily. In Rome, Italy, half the city's 700 casualties of the 2003 European heatwave were over 85 years old—and the heat is believed to have killed as many as 50,000 people throughout Europe.



1973



2001

SHRINKING LAKES

Heat makes water evaporate from the ground surface, drying the soil. If this moisture is not replaced by rainfall, the level of groundwater sinks, draining the water from lakes. People often make the problem worse by diverting water into irrigation schemes designed to revive wilting crops. Over the last 40 years, a combination of these factors has caused the near-disappearance of Lake Chad on the southern fringes of the Sahara. The lake is seen here in two satellite views taken 26 years apart. Once the sixth-largest lake in the world, it is now one twentieth of its original size.

DESERTIFICATION

If there is not enough rain to make up for the evaporation of water from the ground, the soil can gradually turn to dust. This process can be accelerated or even caused by poor farming methods, as happened in the Great Plains states in the 1930s, or more recently in the Sahel region on the southern fringes of the Sahara in Africa. But if rainfall dwindles to below the critical level, even well-managed land will turn to desert. This may be happening in eastern and southeastern Australia, where the rainfall of 2006 was among the lowest on record. Low rainfall is also causing the expansion of the central Asian Gobi Desert, driving dust storms across huge areas of China and Mongolia. This Mongolian woman is carrying water to her home during one of the dust storms.



Scarf protects the woman from airborne dust during the storm



DRIED-UP RIVERS

Reduced rainfall is making some rivers dry up. In 2005 they included the greatest river of all, the Amazon, which suffered its worst drought in 40 years. Many of its tributaries shrank to a fraction of their normal width, exposing broad areas of dried, cracked mud littered with dead fish. The Rio Negro, the main northern tributary of the Amazon, was reduced to its lowest level since records began in 1902.



DROUGHT AND FAMINE

Many people who live on the dry fringes of deserts rely on seasonal rains to make their crops grow and provide water for their farm animals. If these rains fail owing to changed weather patterns, the crops and animals may die, as seen here in southern Ethiopia in 2006. This leaves the people with nothing to eat, and facing the threat of famine.



WILDFIRES

The firefighters on top of this house are desperately trying to save it from a forest fire that ignited during very hot and dry weather. In dry regions such as Australia, many plants are able to cope with regular fires, but during long droughts, the risk of fire can spread to areas where the vegetation is not adapted to survive it. In parts of Amazonia, a combination of drought and deforestation is making the ground so dry that wildfires are raging through forests that have never suffered them before.

Melting ice

IN COLD CLIMATES snow builds up and gradually becomes compacted into virtually solid ice, forming mountain glaciers and polar ice sheets. Polar oceans also freeze at the surface in winter, creating floating pack ice. But a lot of this ice is melting. Arctic pack ice is shrinking, vast Antarctic ice shelves are collapsing, and mountain glaciers are retreating. On the polar fringes, higher temperatures are also melting ice that lies beneath the ground, transforming tundra landscapes.

Ice acts like a mirror, reflecting solar energy

Dark water absorbs energy and gets warmer



ACCELERATING THE MELT

Glittering white sea ice reflects most of the Sun's energy. But if it melts, it gives way to dark ocean water, which absorbs most of the energy and warms up, melting more ice. This positive feedback effect is probably increasing the rate of Arctic sea ice melting.

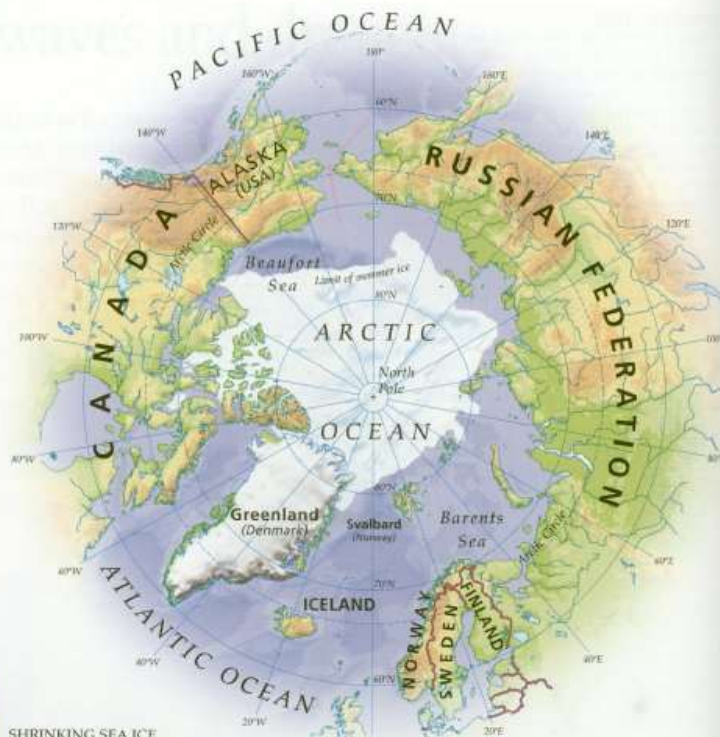


GREENLAND

Most of Greenland is covered by a huge ice sheet, more than 1.9 miles (3 km) thick at its center. Every summer the edges of the ice get thinner, and the area affected by this is increasing. The glaciers that flow from the ice sheet to the sea are also moving faster, increasing the rate at which icebergs break away and melt. Both of these processes are causing the sea level to rise.



Iceberg has broken off floating edge of ice sheet



SHRINKING SEA ICE

In winter most of the Arctic Ocean is covered with a sheet of floating ice up to 10 ft (3 m) thick, and roughly the size of the United States. Half of this area melts in summer, leaving the central Arctic Ocean still icy. Since 1979 the size of this summer ice sheet has dwindled by about 600,000 sq miles (1.5 million sq km)—an area about twice the size of Texas. During the 1990s its average thickness also decreased by 3 ft 4 in (1 m).

MELTING PERMAFROST

About a quarter of the land in the Northern Hemisphere is so cold that it is permanently frozen beneath the surface. This permafrost is covered by a surface layer that is frozen in winter but thaws in summer, creating vast areas of swampland. In many areas of the lower Arctic, the active surface layer is getting deeper each year, melting ancient ice and undermining buildings like this house in Irkutsk, Siberia, which is slowly sinking into the ground.



RETREATING GLACIERS
Glaciers form as snow builds up over the years, packing down to form rivers of ice that creep slowly downhill, scouring deep U-shaped valleys. In the polar regions, many glaciers flow all the way to the sea, where ice breaks off to form icebergs. But most glaciers that form in high, cold mountain valleys turn to streams and lakes of meltwater long before they reach the coast. All over the world, rising temperatures are making these mountain glaciers melt away at their lower, warmer ends, which retreat uphill to where temperatures are lower. The retreat can be dramatic, as shown by these two images of the Upsala glacier in Patagonia, South America—the upper photograph was taken in 1928, and the lower one in 2004.

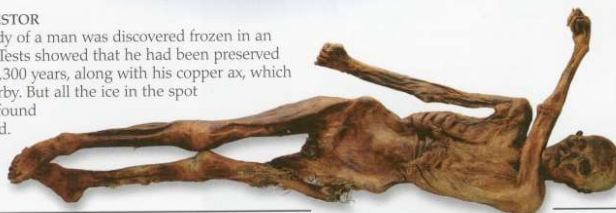
ANTARCTICA

Antarctica is covered by a colossal ice sheet up to 2.8 miles (4.5 km) thick, and covering an area of 5.4 million sq miles (14 million sq km). It consists of the huge east Antarctic ice sheet, east of the Transantarctic Mountains, which seems to be gaining ice, and the smaller west Antarctic ice sheet which is losing ice. The ice is melting fastest on the Antarctic Peninsula, where temperatures are rising more rapidly than anywhere else on Earth, by up to 5.4°F (3°C) since 1951.



FROZEN ANCESTOR

In 1991 the body of a man was discovered frozen in an Alpine glacier. Tests showed that he had been preserved by the ice for 5,300 years, along with his copper ax, which was found nearby. But all the ice in the spot where he was found has now melted.



COLLAPSING ICE SHELVES

In early 2002, 1,250 sq miles (3,250 sq km) of the 650-ft (200-m) thick Larsen-B ice shelf near the tip of the Antarctic Peninsula disintegrated within 35 days, and the fragments drifted away as icebergs. These satellite images show blue pools of meltwater forming on the surface on January 31 (top), and the ice shelf collapsing 23 days later.



RIISING SEA LEVELS

As ocean water warms up, it expands like the liquid in a thermometer, so sea levels rise by a small amount. But gauges like this show a much greater actual rise, indicating that melting ice is adding to the problem.

Warming oceans

THE EFFECTS OF RISING GLOBAL TEMPERATURES are often dramatic on land, causing heatwaves, wildfires, and vanishing glaciers, but their impact on the oceans is less obvious. So far the oceans have not warmed as much as the continents. This is partly because they warm up more slowly. In fact the heat that they have absorbed will make deep oceans keep warming even if all greenhouse gas emissions stopped tomorrow. This will make the ocean water expand, raising sea levels. Meltwater from continental ice sheets is also pouring into the oceans, making sea levels rise much more. Warmer water at the ocean surface reduces plankton growth and carbon dioxide absorption. It also causes more intense storms that sweep over nearby continents, sometimes with catastrophic effects.



MELT WATER

The extra water that is making sea levels rise is coming from melting glaciers and continental ice sheets. If floating sea ice melts, this makes no difference to sea level because the floating ice is already in the sea, and simply changes from solid to liquid. But when ice on land melts, the water that it contains is transferred to the ocean. If this glacier melts away completely, all its water will flow into the sea.

Icebergs are floating lumps of glacier ice



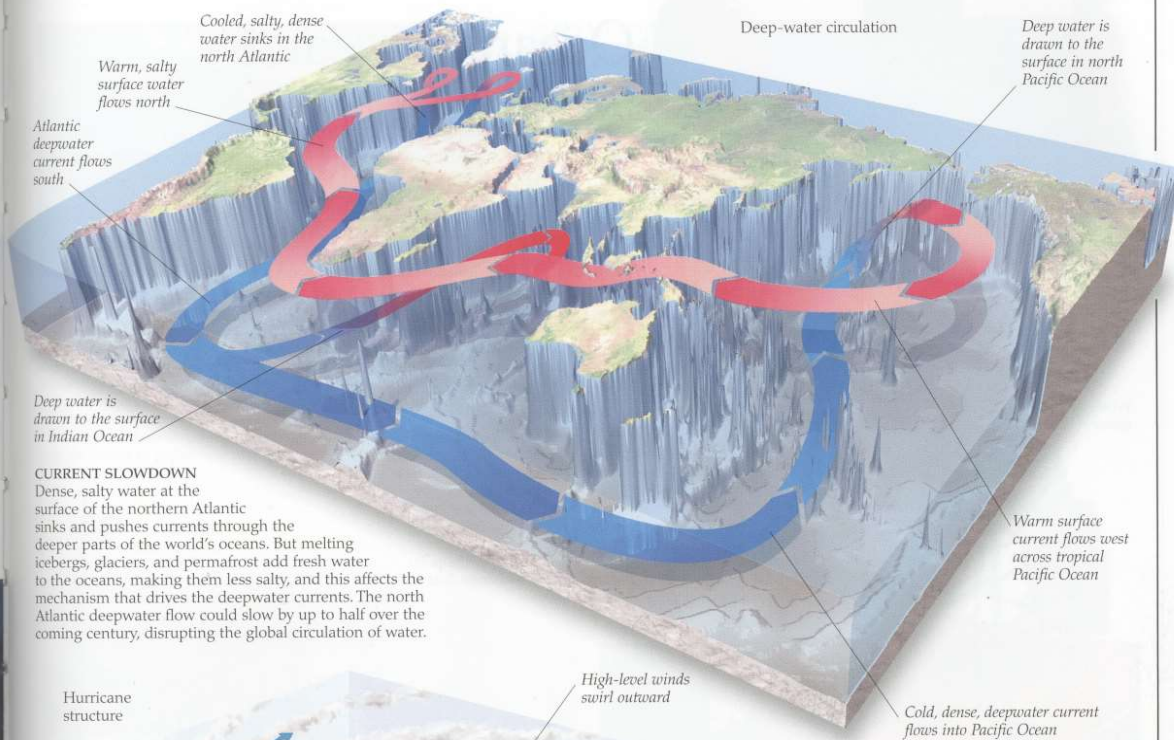
ICEBERGS

In the polar regions, and in a few other places, glaciers flow all the way to the sea. The ends of these glaciers are floating, so when lumps of ice break off, they drift away as floating icebergs. Some of these icebergs are huge, and since they float with up to 90 percent of their bulk underwater, they are all much bigger than they look. They can raise sea levels in the same way as meltwater, whether they melt or stay solid. They can also be a serious hazard to shipping.



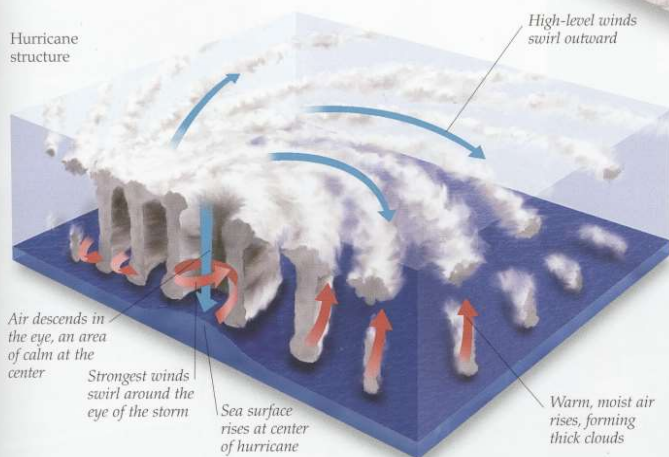
FLOODED OUT

Rising sea levels have already started destroying the coral island nation of Tuvalu in the Pacific, where most of the land lies just 6–10 ft (2–3 m) above sea level. Higher tides are making waves surge further inland, swamping houses and contaminating farmland and water supplies with salt water. Since sea levels are expected to keep rising for 1,000 years after all greenhouse gas emissions stop—and for longer if they don't stop—the 11,000 citizens of Tuvalu will have to evacuate their islands, almost certainly forever. Other low-lying nations such as the Maldives are just as vulnerable.



CURRENT SLOWDOWN

Dense, salty water at the surface of the northern Atlantic sinks and pushes currents through the deeper parts of the world's oceans. But melting icebergs, glaciers, and permafrost add fresh water to the oceans, making them less salty, and this affects the mechanism that drives the deepwater currents. The north Atlantic deepwater flow could slow by up to half over the coming century, disrupting the global circulation of water.



HURRICANES AND CYCLONES

Storms that build up over oceans can cause havoc if they reach land. The storms develop because the Sun's heat causes warm, moist air to rise, creating an area of low pressure at the water's surface, and thick clouds above it. The low pressure draws in more air, which forms a circular wind system called a cyclone. Over tropical oceans cyclones can develop into destructive hurricanes.



SWAMPED CITIES

More intense storms caused by warmer oceans seem to be increasing rainfall in the temperate north by 5–10 percent, causing floods like those that hit England in 2007. Unusually heavy rain has also struck the tropics. The deluge shown here occurred in July 2005, when a massive 37 in (944 mm) of rain fell on Mumbai, India, in 24 hours—50 percent more than the previous record.



CO₂ SATURATION POINT

About one quarter of the carbon dioxide that we add to the air is absorbed by the oceans. It dissolves in the water and a lot is taken up by marine plankton. However, most warm oceans do not contain much plankton, and the oceans are getting warmer. The stormy Southern Ocean around Antarctica—seen here swamping the deck of a racing yacht—also appears to be so loaded with carbon dioxide that it cannot absorb any more. This could be a serious problem, because it accounts for 15 percent of the carbon dioxide soaked up by oceans each year.

WORKSHEET

Name_____

What am I reading about?

From your articles, write down three pieces of evidence for climate change that are convincing to you. Write in full sentences!	Why is the evidence convincing?

LESSON 14: WHAT IS CLIMATE CHANGE? HOW ARE EXTREME WEATHER EVENTS RELATED TO CLIMATE CHANGE?

GOALS

Define climate change as an increase in earth's surface temperature that causes changes in the weather and climate

Discuss the causes and impacts of climate change

Make connections between extreme weather events and climate change

MATERIALS

Readings (Heat waves and Droughts, Melting ice, Warming Oceans)

Chart paper, Easel,

Markers, post-its

Video : NASA sounds alarm on climate change

Computers

ACTIVITIES OF THE LESSON

ACTIVITY 1: OPENING EXERCISES (ABOUT 15 MINUTES)

Whole Class -> Small group: The goal of this activity is to ensure students understand climate change is about earth's rising temperature.

Welcome students. Ask students to recall what we did last week. Give students time to talk to each other and write a few words/sentences on post-it notes. Then, have students share their ideas by reading what they have written on the post-it notes. (Hopefully, the students will bring up the three main readings - heatwaves & drought, melting ice, warming ocean. Write down these big ideas on the board or alternatively, bring attention to the poster with the flowchart on extreme weather events.)

"All of these are relevant to climate change. Today's goal is to put these stories together to understand what climate change really is and be able to explain it to other people who may not know what climate change is. One key aspect of climate change is that the earth's average surface temperature is rising. Earth is getting warmer. This is why people also call it global warming. Here is evidence of temperature rising." Then, show the temperature data..."Let's take a look at this graph from NASA's monthly analysis of the earth's temperature over the years"

http://earthobservatory.nasa.gov/blogs/earthmatters/files/2016/10/tempanoms_gis_september2016.gif

“The increase in the earth’s surface temperature causes lots of other changes on the earth. What does earth’s temperature rise cause?” Then, we will make one or two causal connections together on the board. “For instance, rising temperature causes heatwave.”

ACTIVITY 2: CAUSAL MAPPING: (ABOUT 25 MINUTES)

Small Groups: The goal of this activity is to put aspects of climate change together and make cause-effect connections.

At this point, climate change is explicitly defined as “the rise in average surface temperatures that can potentially cause a drastic shift in weather and climate”

Instruct students to form groups of 3 and ask them to make a causal map. Tell them that they will create a short video that explains about what climate change is to their parents and siblings.

They can start with : Rising Temperatures causes ____ which causes ____ that then leads to _____. (The idea is to map out the impacts of climate change - what may happen, how it may affect people/animals, how would people adapt, etc. They can also add questions to their map if they are unsure).

Facilitators will show an example that we created.

Make sure everyone has a marker.

Facilitators should encourage the use of the readings from WK 13. Focus on the main paragraph of each reading and ensure that students make a connection among the extreme weather events.

Encourage use of other online resources as they want
<https://www.epa.gov/climate-change-science/understanding-link-between-climate-change-and-extreme-weather> (tinyurl.com/RESET-WK14)

Also, facilitators encourage them to think “what causes the temperature rise” and “what are impacts of climate change on us.”

ACTIVITY 3: DEVELOPING A MAP TOGETHER (ABOUT 15 MINUTES)

Whole group: The goal is to build a consensus map for the whole group.

Each group will compare and contrast their own group’s map and other’s to build a larger / consensus causal map.

Alternatively, we will do gallery walk.

Hang their chart paper on the wall. Group members stand by their map. Two people rotate counterclockwise. See what the group has in their map. Find at least one

difference, ask the developer of the map, and then come back to their own map. Then, add it to their own map. Repeat it multiple times.

ACTIVITY 4: VLOGGING (ABOUT 20 MINUTES)

Small Groups: Each group will create a short video clip to explain *what climate change is to their parents and siblings*.

Facilitators can help video shooting.

Encourage them to speak multiple languages as well if needed.

They can record wherever they want. They can do in front of their map or somewhere else.

ACTIVITY 4: WRAP UP (ABOUT 10 MINUTES)

Whole group: To end the session, this video published January 18, 2017 can then be shown.

NASA sounds the alarm on climate change. (1:48)

<https://www.youtube.com/watch?v=-uPSXLaLv8Q>

So now we have a better understanding of what climate change is, how extreme weather events are indicators of climate change, and the impacts of climate change. But until now, there is still a debate on whether climate change is real or a hoax. What do you think of that? Are you convinced that climate change is happening or do we not think the evidence are not convincing enough? Can you think of whether climate change has affected you personally?

We may ask what other questions that they still have about climate change.

Wrap up with: Next meeting, we will explore what carbon emissions are and investigate the cause of climate change.

FACILITATOR'S NOTE

We were unable to do Activity 4.

Readings for this week are the same from Week 13.

Greenhouse Gas Effect

A greenhouse is a house made of glass or plastic. It stays warm inside even during night and winter. Earth's atmosphere (air!) works like a giant greenhouse for all living things on the earth. The earth absorbs heat from the sun during the day. The atmosphere keeps some heat from escaping the earth at night. This is called greenhouse effect. Imagine what would happen if there were no air: we would all freeze at night and die. However, if the greenhouse effect is too strong, the earth gets warmer and warmer. This is what is happening now. Too much carbon dioxide and other greenhouse gases (gases that cause greenhouse effect) in the air are making the greenhouse effect stronger. How do we know that there is too much carbon dioxide in the air? Why are there more greenhouse gases in the air?



Greenhouse for growing plants (Image Source:

<http://site.outdora.com/blog/pros-cons->

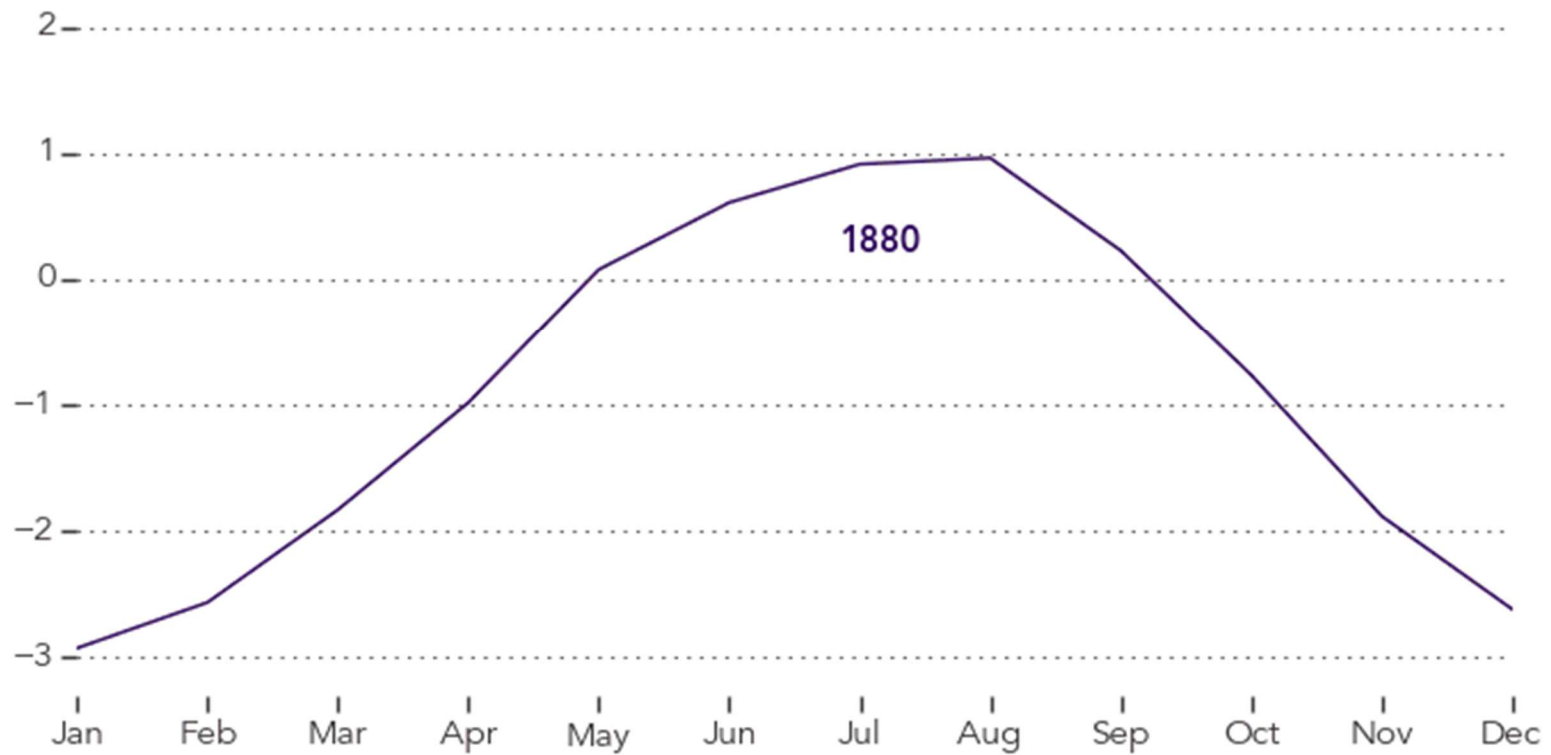
(Adapted from: <http://climatekids.nasa.gov/greenhouse-effect/>)

GRAPHS ON TEMPERATURE ANOMALIES

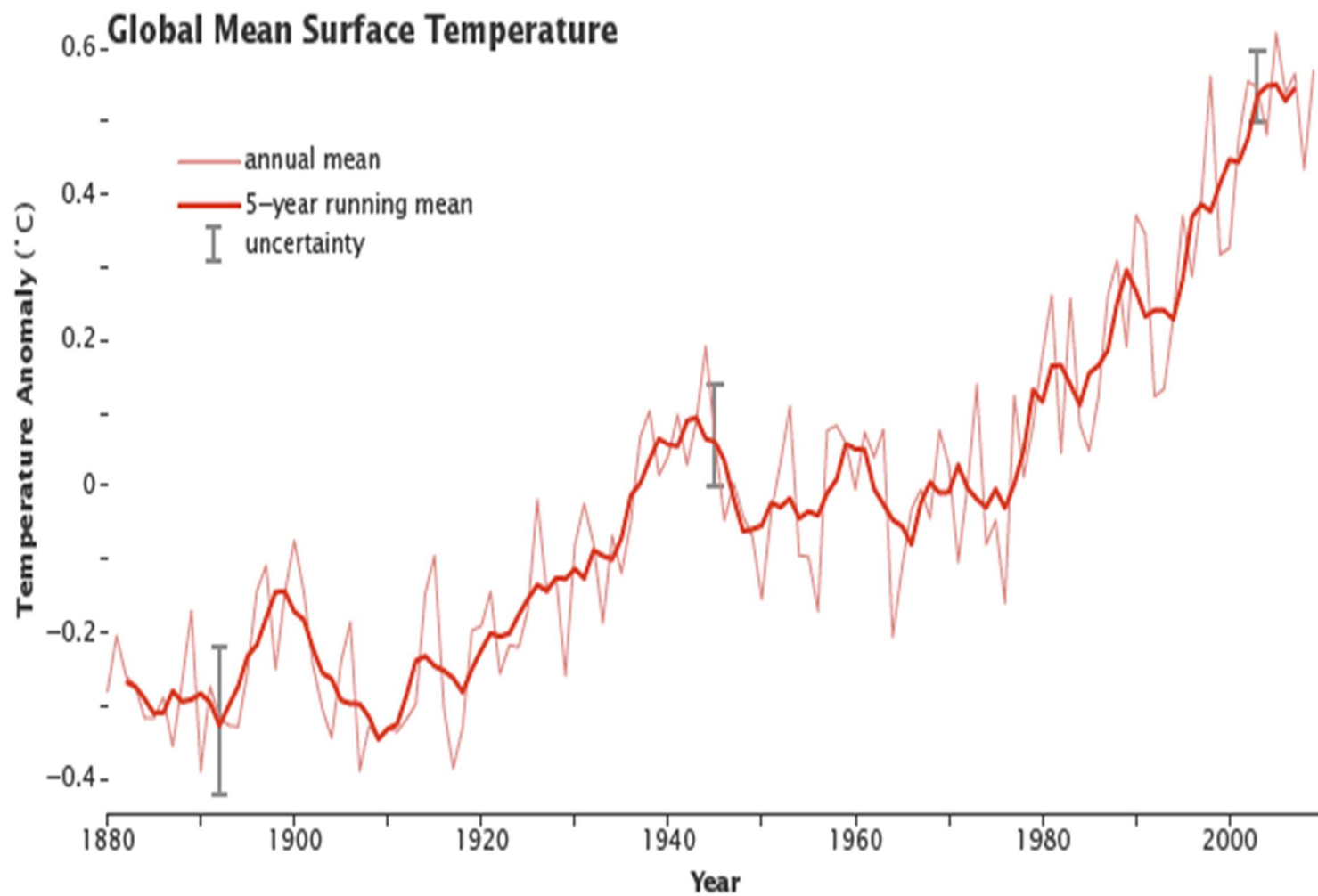
Monthly analysis of global temperatures by NASA's Goddard Institute for Space Studies (GISS)

Temperature Anomaly ($^{\circ}\text{C}$)

(Difference from 1980-2015 annual mean)



Surface Temperature Analysis



LESSON 15: WHAT CAUSES CLIMATE CHANGE? HOW WILL CLIMATE CHANGE AFFECT US?

GOALS

Pursue questions raised from previous week through online research

Discuss what causes climate change

Discuss how the world may be impacted through climate change

MATERIALS

Chart paper, Easel,

Markers, post-its

Computers

Posters from the previous week

Posters of questions

Powerpoint slide of Photos of Earth Changes

Printouts of Model Maps for each question

Reading materials

Stickers

ACTIVITIES OF THE LESSON

ACTIVITY 1: OPENING EXERCISES (ABOUT 15 MINUTES)

Whole Group

Welcome students. Ask students to write down one or two sentences about what climate change is. Then, students will share in their small group.

To transition, show the powerpoint slides of photos showing changes in the Earth in the Past 100 years. Ask students their thoughts about the photos.

Show poster papers from last week. "We all started the climate change story with the idea that earth's temperature is rising. We don't know yet what causes the earth's temperature to rise. Scientists have shown that there is relationship between increasing carbon dioxide levels and the earth's temperature rise. Carbon dioxide causes the earth's temperature to rise."

“What is carbon dioxide?” Gas that is contained in the air. Less than one percent in the air. Plants absorb carbon dioxide and generate oxygen. People need oxygen to breathe in. It is contained in some fire extinguishers and also soft drinks (carbonated).

“Now, we have more ideas about climate change. But we still have some questions.” Show them questions from last week. “Today, we are going to pursue these questions. The goal for today is in your small group, you will figure out answers to these questions and teach it to the entire group.”

“All of you now stand up, come out, and write down your name on a post it and place it next to one of these questions. When you sign up for these questions, you need to consider what you are interested in. We would like all questions to be answered by someone. So make sure we have enough people for each question as well.”

Facilitators make sure that students are seated to face each other, rather than in a row.

ACTIVITY 2: ONLINE RESEARCH (ABOUT 40MINUTES)

Small groups

How does carbon dioxide cause earth’s temperature to rise?

Does earth’s rising temperature cause more tornadoes? If so, how?

What areas are most affected by climate change?

Facilitators should scaffold the questions to the students using these general strategies to answer these questions.

Analysis of the question: What does the question ask? How to further break down this question? What might be some potential answers? What are some key terms?

Search online

What are good ways to search in google and/or youtube? (e.g., search terms, dictionary, selecting right sources, use of images)

Search for information or Check our proposed answers

Evaluate: Is the source reliable? What does this source say?

Synthesize: What is causal relationship between any set of two ideas? What supports the relationship? (data, logic, experience, etc.) What is the best way to present my answer to the group?

Each group will be given the short reading and the small group will discuss for a few minutes. Students will use post-it notes to write down information that they got from the reading and their questions.

Then, the laptop, additional reading materials (Question 3), a printout of the model “map”, chart papers, and markers will be given . Facilitators will help students formulate their ideas.

ACTIVITY 3: GALLERY WALK (ABOUT 20 MINUTES)

Small groups

Students will put up their posters on the whiteboard. Half of each group members will stay and the other half will go to other groups to learn. The staying group is responsible to teach visitors in their group. After 10 minutes, they will rotate. Those who stayed at their poster will go to other groups' posters and learn from them.

Everyone should take turns learning and teaching. As students go around, they will write down their questions on post-it notes and place them by the posters. If there are parts that make a lot of sense to them, put stickers on those parts.

ACTIVITY 4: FORECASTING THE FUTURE (ABOUT 15 MINUTES)

Whole Class

As a group, students will co-construct on the board their answer to the prompt:

“What will the earth be like 100 years from now if climate change continues?”

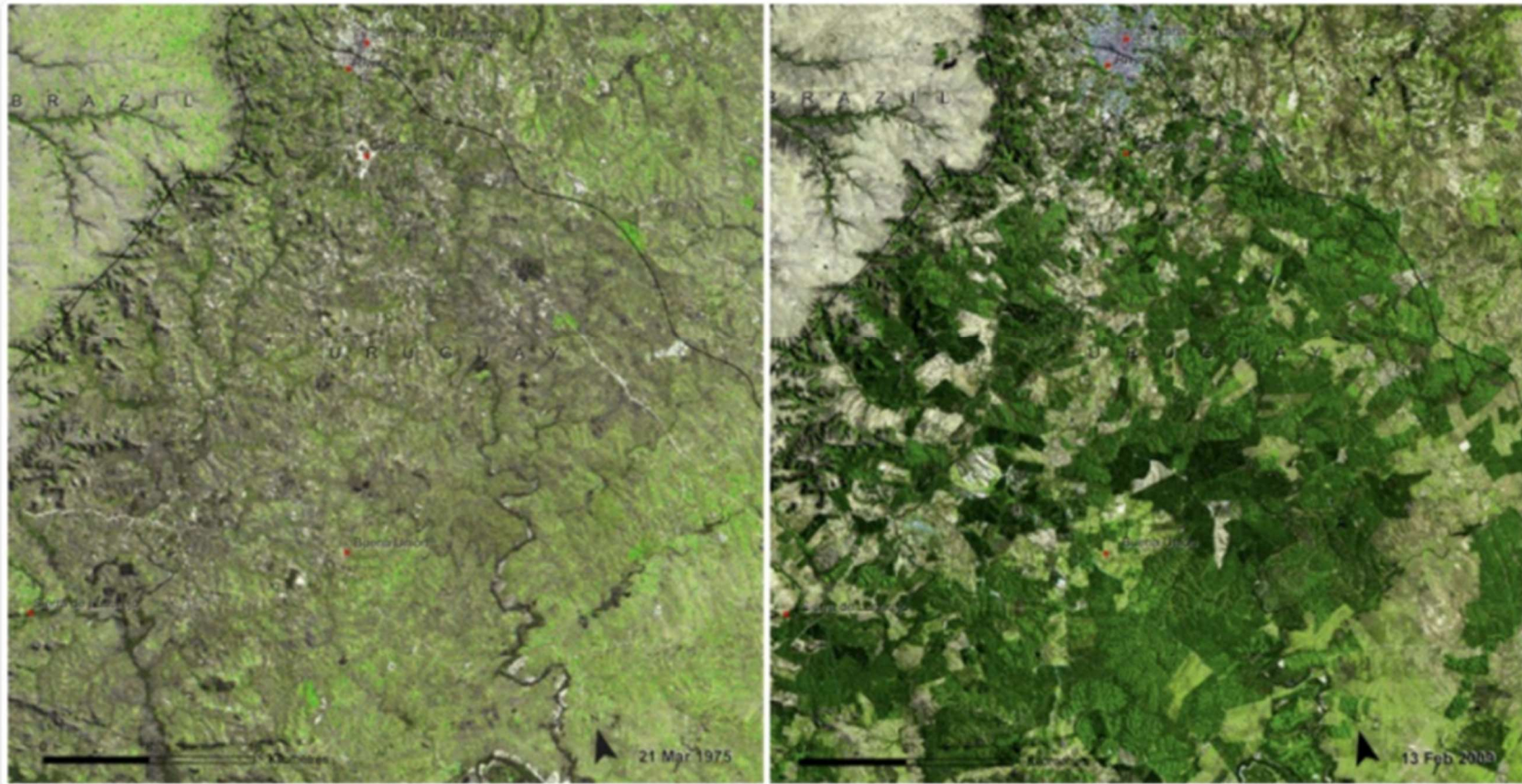
Wrap up.

FACILITATOR'S NOTE

We were unable to do Activity 4.

PHOTOS OF EARTH'S CHANGES

Uruguay Forests, March, 1975 — February, 2009



Lake Oroville, California. July, 2010 — August, 2016



Aral Sea, Central Asia. August, 2000 — August, 2014



Pedersen Glacier, Alaska. Summer, 1917 — Summer, 2005



Carroll Glacier, Alaska. August, 1906 — September, 2003



Powell Lake, Arizona and Utah. March, 1999 — May, 2014



Forests in Rondonia, Brazil. June, 1975 — August, 2009



Bear Glacier, Alaska. July, 1909 — August, 2005



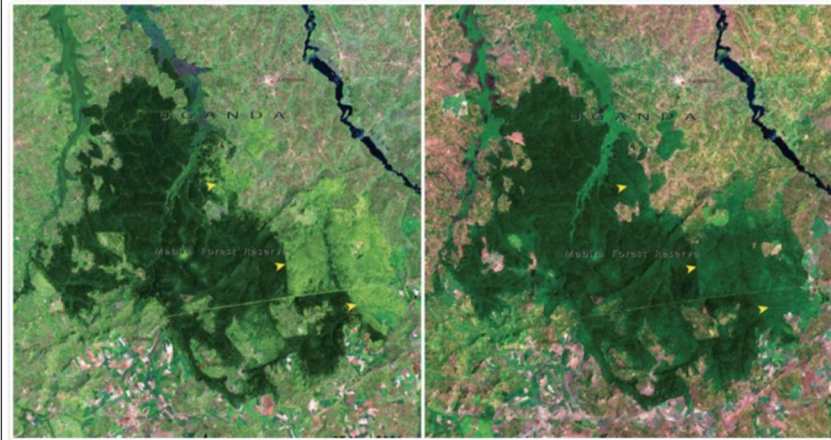
McCarty Glacier, Alaska. July, 1909 — August, 2004



The Dasht River, Pakistan, August, 1999 — June, 2011



Mabira Forest, Uganda. November, 2001 — January, 2006



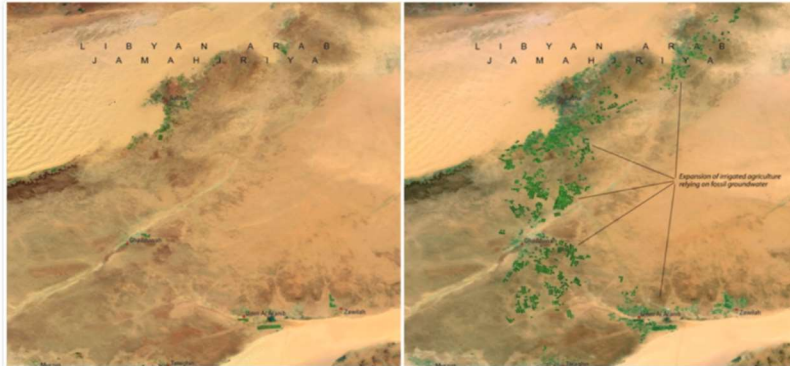
Matterhorn Mountain in the Alps. August, 1960 — August, 2005



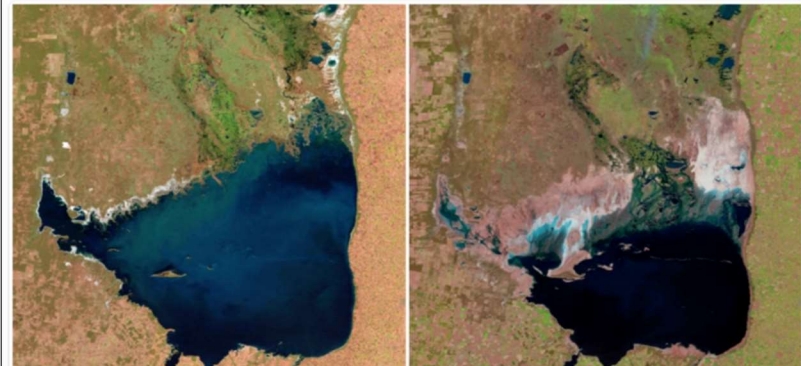
Toboggan Glacier, Alaska. June, 1909 — September, 2000



Great Man-Made River, Libya, April, 1987 — April, 2010



Mar Chiquita Lake, Argentina. July, 1998. — September, 2011



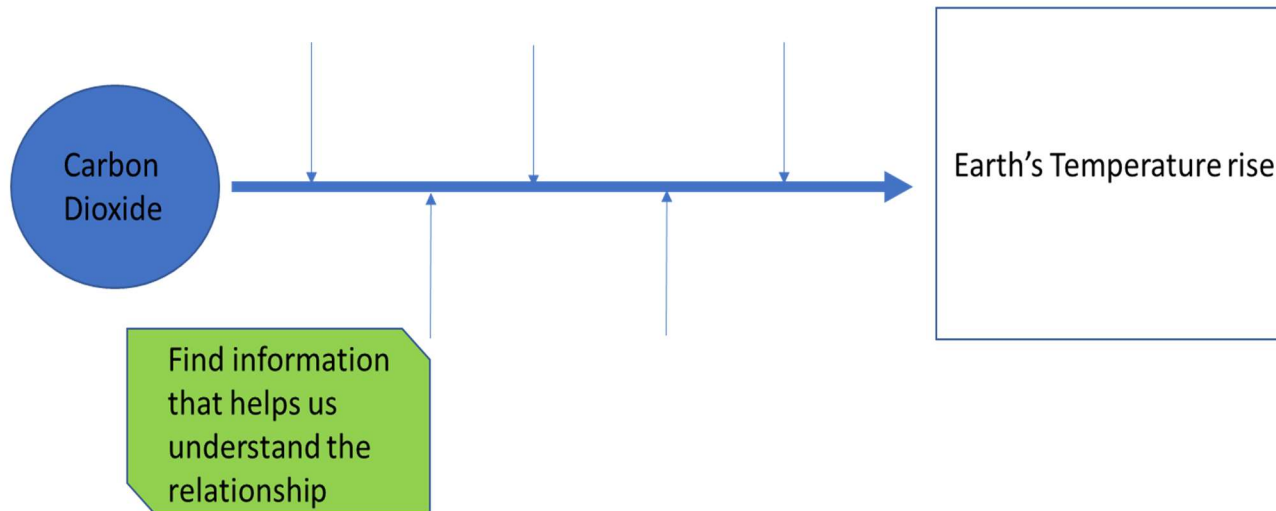
Qori Kalis Glacier, Peru. July, 1978 — July, 2011



Muir Glacier, Alaska. August, 1941 — August, 2004

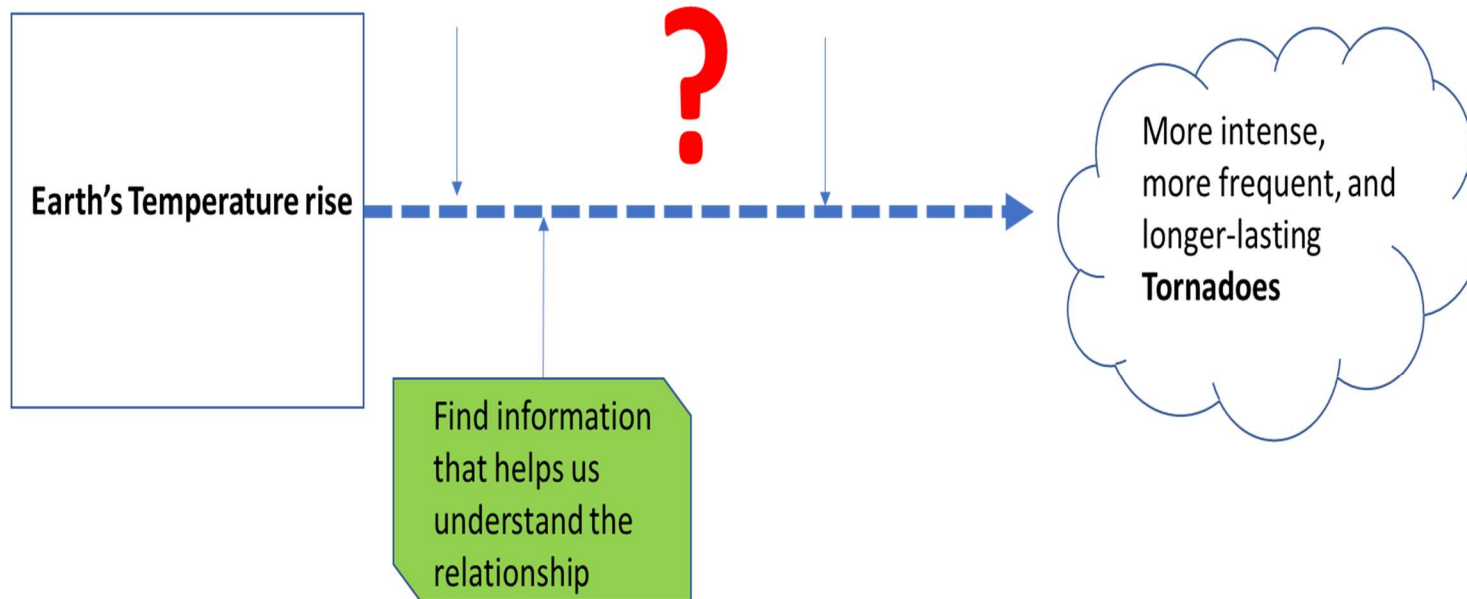


How does carbon dioxide cause earth's temperature to rise?

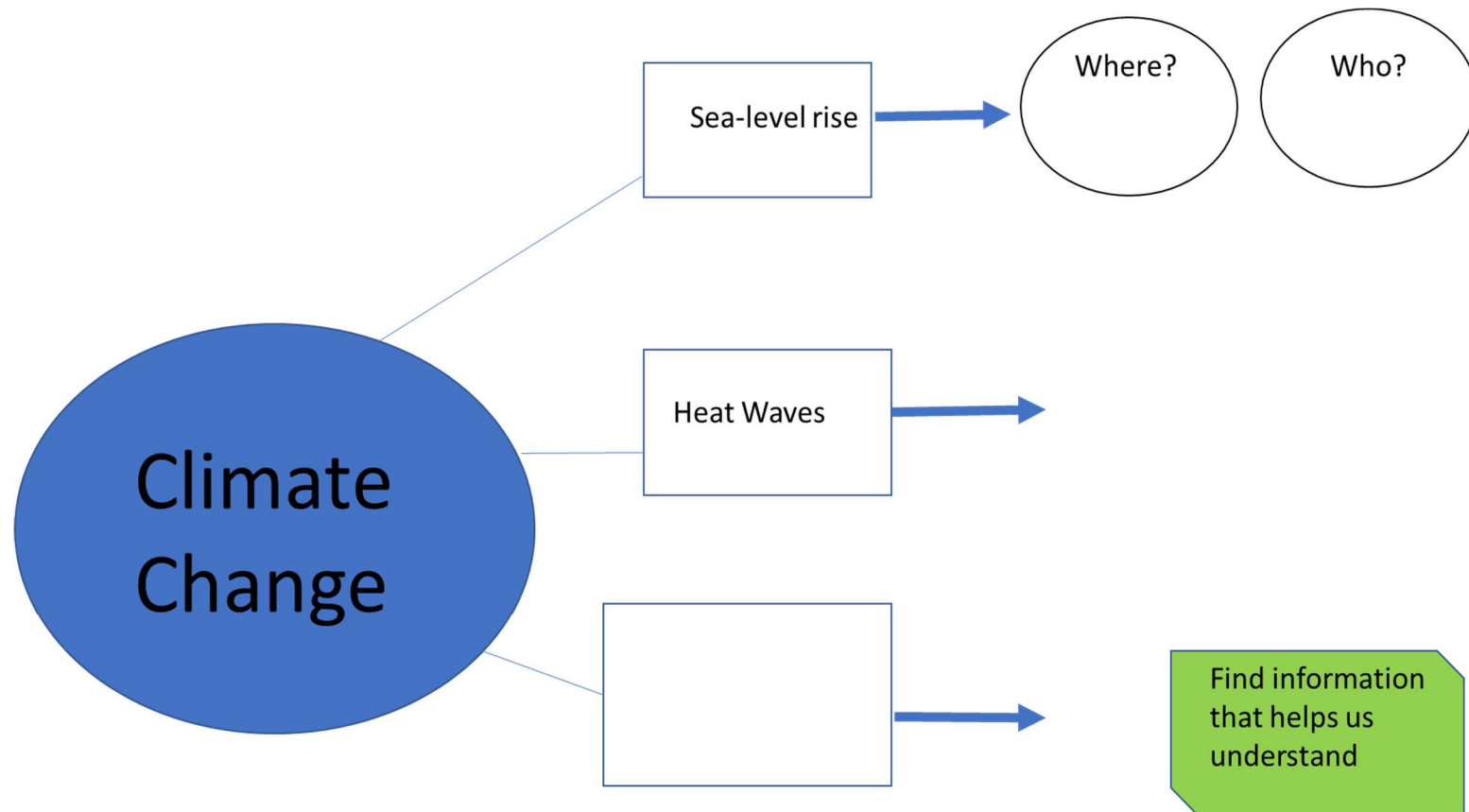


Does earth's rising temperature cause more tornadoes? If so, how?

381



What areas are most affected by climate change?



LESSON 16: WHAT WILL THE EARTH BE LIKE 100 YEARS FROM NOW IF CLIMATE CHANGE CONTINUES?

GOALS

Synthesize the ideas we have explored since Week 13

Clarify confusion on the relationship of carbon dioxide and climate change

MATERIALS

Chart paper, Easel

Markers, post-its

Posters from the previous week

Computers

Reading materials

Powerpoint on “Is carbon dioxide in the air good or bad?”

Poster with the names of the 8 locations

Stickers

FLIR thermometers

ACTIVITIES OF THE LESSON

Before the session starts, have students explore the IR thermometers. Brief them that you can see the differences in temperature. The goal of this exploration is to draw out the idea of “heat that we cannot see” and the heat that is given off of a certain object. Encourage them to observe different objects, including people, and help them interpret the image. Ask them what they see and what they have figured out. What gives off much heat and what gives off less?

ACTIVITY 1: OPENING EXERCISES (ABOUT 20 MINUTES)

Whole Group

Welcome students. Ask if they found out anything interesting with the thermal imager. ... Hopefully, how each object gives off different amount of heat; if we are covered with clothes, we give off less heat, etc.

Point to the posters and say, “So last week, we answered three questions that we came up with. Can someone recall what we learned?” Give students time to discuss with their seatmates and have students share their ideas in their small group. Ask them to make a mini-poster to summarize answers for all three questions. Check individual groups what they have in their mini-poster. If needed, we can have each group present/reiterate what they have found the week before.

Then, recall that we had a question that came up during the presentation - whether carbon dioxide in the air is good or bad. Ask students what they think. Depending their answers, the explanation can vary, however it will go something like this (with images and short sentences in PPT).

Carbon dioxide is part of air (or atmosphere) that surrounds the earth. Why do we need air? It provides oxygen that we need for breathing. What else? (photosynthesis?)

Another thing that we benefit from air is that it keeps the earth’s heat. Earth gives off heat that it gets from the sun. But air traps some heat from completely escaping the earth. it’s like coats that we wear in cold winter. If not coats, we would have lost all heat from our body and can even die.

Use/show thermal imagers.

People call this phenomenon--that the earth’s air traps a certain amount of heat within the air and keep the earth warm--greenhouse effect. It is because the air works like a greenhouse. (We use greenhouse in botanic gardens to grow tropical plants and in farming to grow vegetables in winter).

If appropriate, illustrate greenhouse effect further by using a hot potato. Say something like, “When we take out a baked potato and cover it with a sheet of foil, we keep the heat longer but eventually the steam escapes, the potato cools and we can eat our baked potato. But what if we cover it with more foil? Then the heat will have a hard time escaping, and the potato will remain hot. In this analogy, the sun is the heat source, the earth is the potato and the foil are the greenhouse gases. Greenhouse gases are good to a certain extent because we need them to keep our planet warm otherwise we will all freeze. But too much of it causes a rise in temperature and we know what happens with that. (This may also be an opportunity to review how climate change causes extreme weather events and how it impacts people.)

it’s also like a car on a hot summer day. It keeps the heat inside.

Some gases in the air contribute to this greenhouse effect. the most important contributor is carbon dioxide.

Greenhouse effect itself is not a bad thing. without it, we would have all died at night. However, when there are too much amount of greenhouse gases and they keep too much heat within the atmosphere of the earth, we get in trouble.

Point out that this greenhouse effect is good - otherwise, everything will be frozen and we cannot live on earth. But, if we have too much of these greenhouse gases, that would mean that we will keep trapping more and more heat. The graph shows that since with increasing carbon dioxide in air, we are also seeing an increasing trend in earth temperature. Explain the details of the graph.

After the short explanation of greenhouse effect, students will revise their mini-poster.

ACTIVITY 2: DRAWING WHAT WILL HAPPEN TO THE EARTH 100 YEARS FROM NOW IF CLIMATE CHANGE CONTINUES (ABOUT 40 MINUTES)

Pairs

Transition: We have now talked about the causes and the effects of climate change. For this next activity, we would like to illustrate our understanding of climate change by forecasting what may happen to the earth if climate change continues. Tell them that they are working in pairs. "We are going to mix up people. You find your partner based on how much you know them. The goal is to get to know new people and also help new people fully participate in our activities. So students from last semester should find their partner and collaborate with them as much as they can."

Show the poster with the list of the 8 locations. Have students sign up for the locations by writing their names beside the location. Emphasize that this is a team effort and that all members should contribute in the design and drawing. Tell them that they can research online and use the reading materials as resources. At the end of the activity, they will be presenting their posters and vlog about it.

Prompt: We have here a list of 8 locations. We would like you to think how these areas may look like in a 100 years if climate change continues or earth's temperatures keep rising. Think of what the land and the bodies of water will look like. Consider how earth's rising temperature may affect the plants, animals and people. How may people live their daily lives in 100 years?

Chin State,Burma

Kuala Lumpur, Malaysia

Accra, Ghana

Indianapolis, Indiana

Baghdad, Iraq

Sydney, Australia

Barcelona, Spain

Nord, Greenland

After 25 minutes into the activity, remind students that they need to have their posters ready in 15 minutes.

ACTIVITY 3: PRESENTATION/VLOGGING (ABOUT 30 MINUTES)

Pairs

Students will post all of their posters on the board. Before they present, remind the students that the goal is to have the class understand their message. If there are a relatively large number of students, we can spread them out throughout the room, which may make the presentation more formal. Half of the groups will move around and see other posters while the other half groups remain next to their poster and explain. Then, the half will take turn to observe other groups' posters. They may choose to present in whatever language they feel comfortable in. They also have to make sure that all members have to say something in the presentation. As they walk around, they will give stickers to the posters that they liked and made sense to them. Students in the audience will write on post-it notes a question they have for the group.

Wrap-up. Depending on time, and if any group is interested, we can make a short video presentation to be posted on the facebook page.

FACILITATOR'S NOTE

We ran out of time doing Activity 2. We only got to the research and discussion. Students never got to finish their drawings.

IS CARBON DIOXIDE IN THE AIR GOOD OR BAD?

**The earth is
surrounded by air
(atmosphere).**



<http://news.mit.edu/2016/oxygen-first-appearance-earth-atmosphere-0513>

**The atmosphere traps
heat from the earth.**

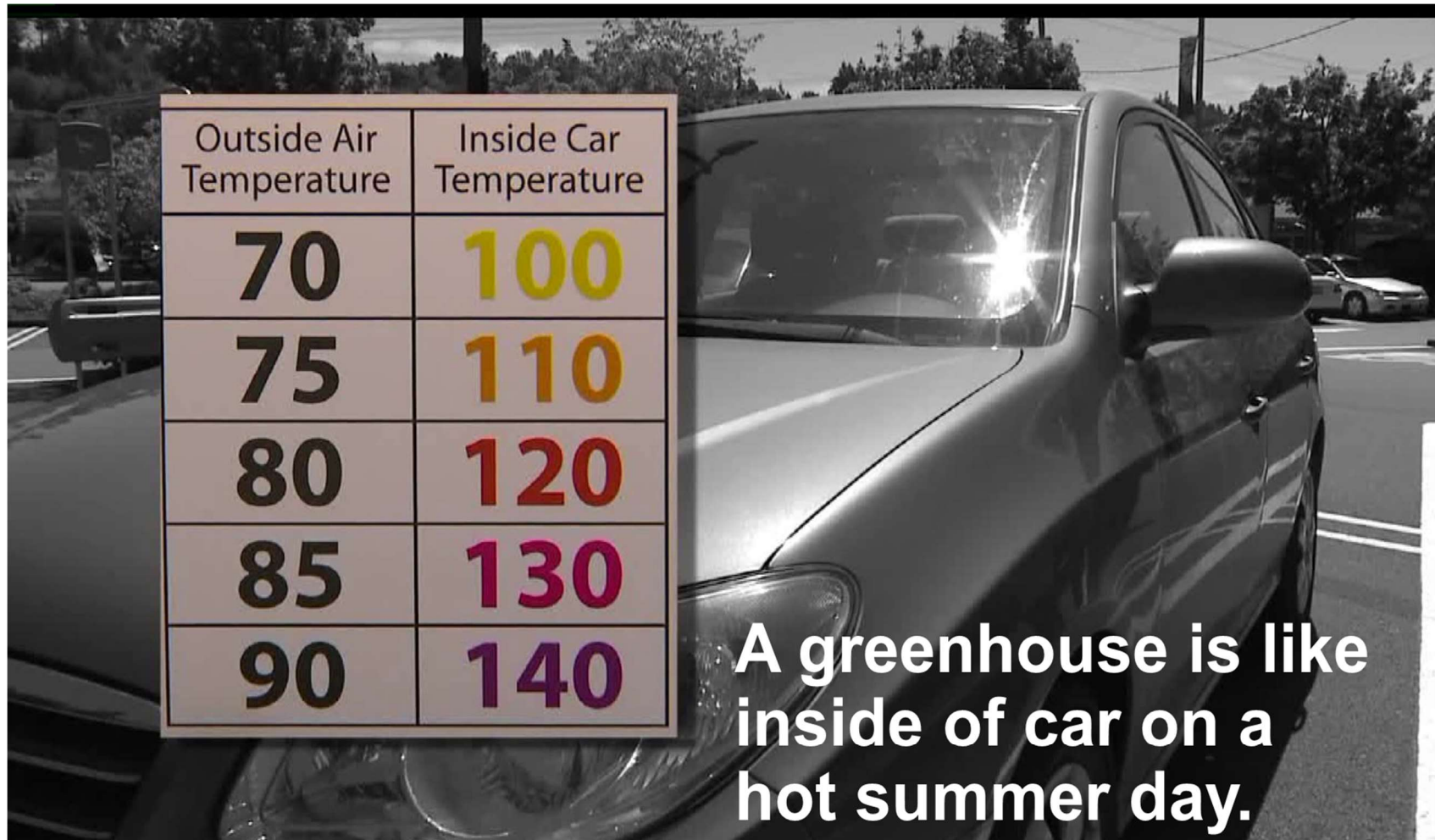


http://www.slate.com/blogs/atlas_obscura/2014/01/31/yakutsk_siberia_surviving_winter_in_the_world_s_coldest_city.html



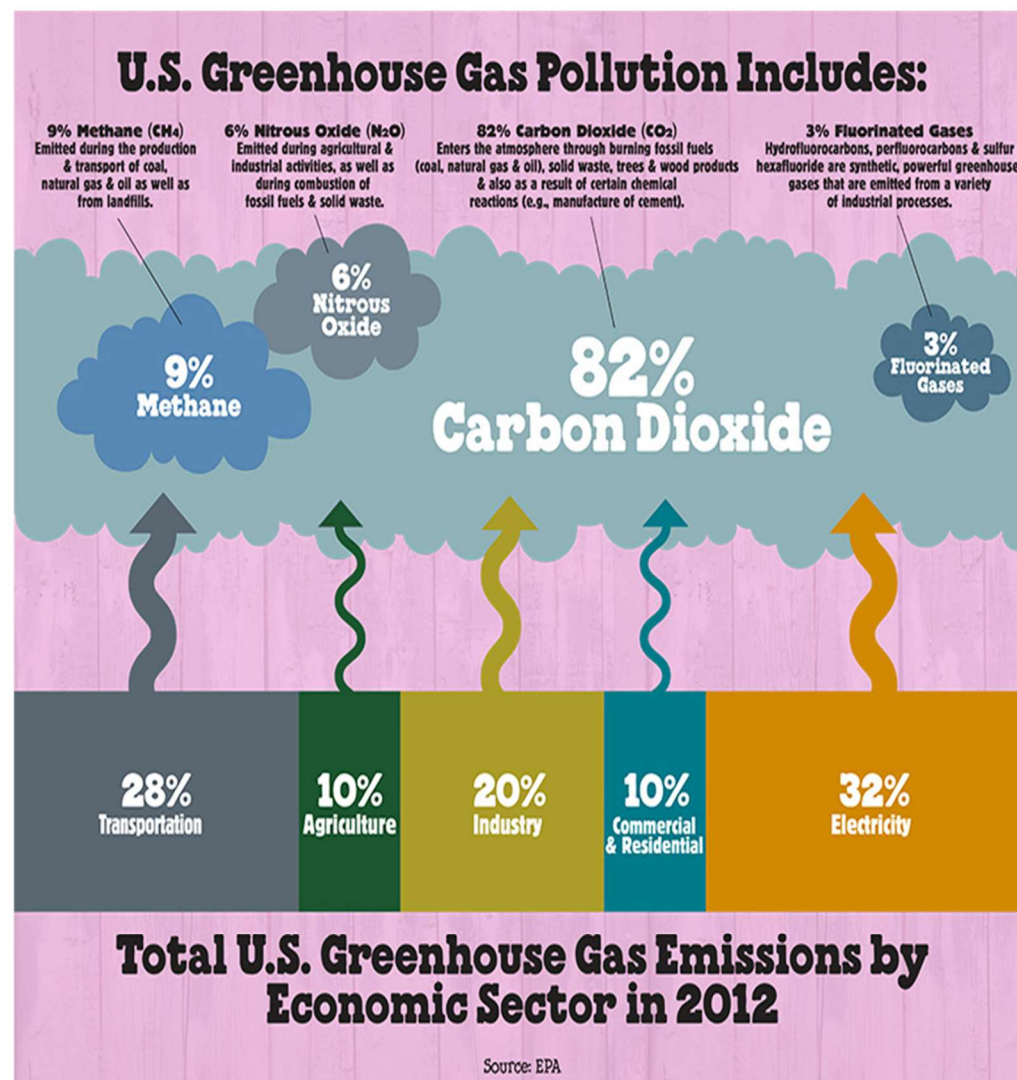
**The earth's atmosphere is like a greenhouse.
People call this phenomenon a "greenhouse effect."**





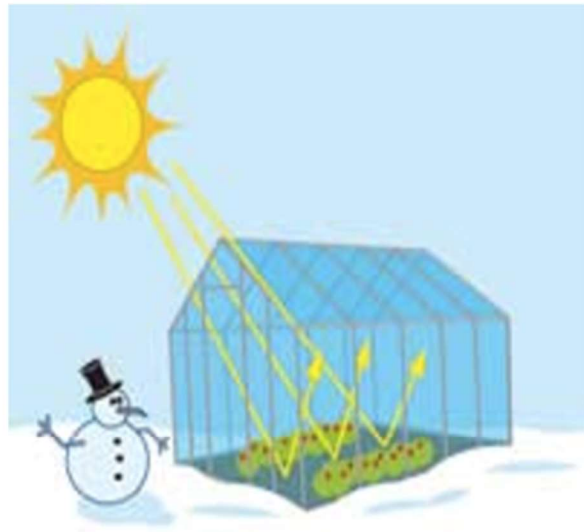
<http://q13fox.com/2014/07/09/what-to-do-if-you-see-a-dog-or-child-in-a-hot-car/>

Gases that contribute to greenhouse effect are called greenhouse gases.

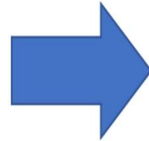


<http://www.benjerry.com/values/issues-we-care-about/climate-justice/greenhouse-gases-101>

The good: Carbon dioxide is a greenhouse gas. It keeps the earth's temperature warm, not too cold.



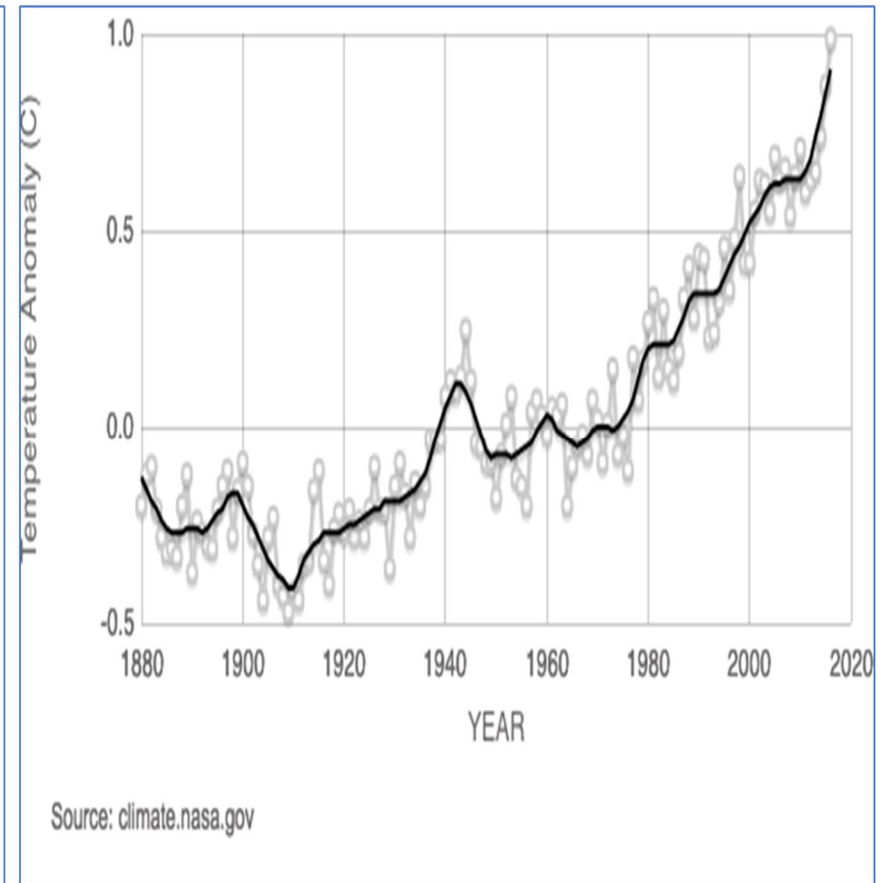
A greenhouse traps the Sun's energy inside and keeps the plants warm.



If not for the greenhouse effect, Earth would be an ice ball.

<http://climatekids.nasa.gov/carbon/>

The bad: Recently, more greenhouse gases (mostly carbon dioxide) are emitted to the air. They trap more heat within the earth's atmosphere, making the earth's temperature rise.



LESSON 17 : (CONTINUATION) WHAT WILL THE EARTH BE LIKE 100 YEARS FROM NOW IF CLIMATE CHANGE CONTINUES?

GOALS

Continue drawing the posters

MATERIALS

Chart paper, Easel

Markers, post-its

Posters from the previous week

Posters with this week's questions

Computers

Reading materials

Worksheet

ACTIVITIES OF THE LESSON

ACTIVITY 1: OPENING EXERCISES AND BRAINSTORMING (ABOUT 15 MINUTES)

Whole Class-Small group.

Welcome students. We will then spend time brainstorming and remembering what we did the previous week. Remind them the question prompt: “how may these areas (eight cities) look like in 100 years if climate change continues or earth’s temperatures keep rising? Think of what the land and the bodies of water will look like. Consider how earth’s rising temperature may affect the plants, animals and people. How may people live their daily lives in 100 years?”

Facilitators make sure everyone is assigned to a group (original group membership, distributing new members to different groups). Give them time to reflect on what we did two weeks ago and where they left. If there are new members in each group, old members need to make sure that the new members know what is going on.

Facilitators ask each group about their progress:

“What is your city? Where is it located? What is its current climate like?”

“What did you figure out about this city? What do you need to know more?”

After having this reflection, we will transition to the poster activity.

ACTIVITY 2: MAKING THE POSTERS (ABOUT 45 MINUTES)

Pairs (or group of three)

Students will then continue with making their posters from the previous week.

Rule: everyone contributes to the poster.

“Online search doesn’t always provide the answer you are looking for. You need to analyze the question, break them down to figure out what information you need to answer this question, and search information for specific questions.”

Guide students thinking: “Some strategies may include, think about 1) what climate change causes (e.g., drought, severe hurricane, ocean rise, and where these events occur), 2) what climate your city has and where it is located geographically, and 3) Based on its geographic location, current climate, and consequences of climate change, to what phenomena of climate change is this city most susceptible to?”

Guide students to search for specific events that are occurring in each city. They can search for news articles, magazine, some organization that does research on climate change (EPA, NASA, NOAA).

“You can make your poster using ways to best communicate your answers--texts both in English and your home language, drawings, graphs, etc. It doesn’t have to be pretty. The goal is to have other people understand your message.”

ACTIVITY 3: PRESENTATION (ABOUT 15 MINUTES)

Pairs (or groups of three)

Students will post all of their posters on the board. Before they present, remind the students that the goal is to have the class understand their message. If there are a relatively large number of students, we can spread them out throughout the room, which may make the presentation more formal. Half of the groups will move around and see other posters while the other half groups remain next to their poster and explain. Then, the half will take turn to observe other groups’ posters. They may choose to present in whatever language they feel comfortable in. They also have to make sure that all members have to say something in the presentation.

As students go to each poster, they will write on a post-it their answer to the prompt:

Imagine you go home tonight and tell your family what you have learned from each poster. What will you tell your family about the poster? (you can use any language that you want.)

The post-its will then be posted beside the posters.

ACTIVITY 4: SHARE OUT (ABOUT 15 MINUTES)

Whole Class

After everyone has had a chance to go around the posters, two chart papers bearing the questions :

“Among the 100 year predictions, is there anything that worries you? Why/ Why not?”

Any questions that you want to explore?

Gather everyone in a circle. Discuss what prediction worries them the most. Why?

Ask them what questions they may have that were not yet answered when they went around the posters.

ACTIVITY 5: WRAP-UP

Depending on time, and if any group is interested, we can make a short video presentation to be posted on the facebook page.

FACILITATOR’S NOTE:

We were not able to do activity 5.

WORKSHEET

PLACE FEATURED IN THE POSTER	WHAT HAPPENS IN 100 YEARS IF CLIMATE CHANGE CONTINUES?	QUESTIONS?
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		

WHAT IS COMMON ACROSS ALL POSTERS?	AMONG THE 100 YEAR PREDICTIONS, WHICH ONE WORRIES YOU THE MOST? WHY?	AMONG THE 100 YEAR PREDICTIONS, WHICH ONE DOES NOT WORRY YOU SO MUCH? WHY?

LESSON 18 : VIDEO MAKING WEEK 1: WHAT DO WE WANT TO SAY? WHO DO WE SAY IT TO?

GOALS

Brainstorm ideas for the message/audience of the video project

MATERIALS

Markers, post-its

Mini chart papers

Posters from the previous sessions

Posters with prompts

Computers

Reading materials

Video making booklet

ACTIVITIES OF THE LESSON

ACTIVITY 1: WARM UP (ABOUT 15 MINUTES)

Whole Class

Welcome students. Have everyone sit on the floor. Pass cookies around.

“We talk about climate change and global warming a lot. (Make sure students know what the phrase global warming means. We have not been used it.). Since last Monday, two questions were sticking in my mind. first, someone raised a question of how we can stop climate change, or if there is anything we can do to slow it down.” Solicit opinions.

“I also wondered how we translate climate change and global warming in our home languages. I need to translate it to Korean to talk to my parents and friends in Korea. Did you also have to translate it to your home language? Have you talked to your family about what we learn in our RESET program?” Place the posters with “Climate Change/Global Warming” in the middle of the floor. Have students/facilitators translate the words in their home languages. The words may not be translatable so ask that they give the best definitions they can give in their home languages.

ACTIVITY 2: RECALL (ABOUT 25 MINUTES)

Small groups

“For the rest of this semester, you are going to make a video in this group. This is your group membership. First thing you need to do when you are assigned to a group is to make sure everyone

understands each other and is on the same page. Let's make sure that everyone in your group is on the same page, because some of you have missed some sessions. Talk to each other about what is climate change, what is the cause of it, and how it impacts human lives." The posters from previous weeks should be helpful in jogging their memory. Give students some time to talk to their small group. *(About 10 minutes)*

"Now, let's think about some remaining questions. What are some questions you still have about climate change and would like to know more about? Video production can be a great opportunity to pursue those questions as well." Have students make a mini-poster to summarize what they have learned and write down what questions they still have. *(About 10 minutes)*

ACTIVITY 3: BRAINSTORMING ABOUT THE VIDEO PROJECT (ABOUT 40 MINUTES)

Small Groups

It would be best to have a designated facilitator for each small group. The purpose of this activity is to generate ideas for their video project. Tell students that the booklet is a space where they can write down ALL possible ideas. Have all students have post-its and markers during the discussion so everyone has a chance to contribute. Post-its will be posted on the page bearing the question. Facilitators should ensure that ideas are talked about in the group.

Facilitators should guide the students in discussing:

- 1) What is the purpose of the video? Small groups can discuss whether they want their video to teach their target audience/ make their target audience do something etc. A way to generate ideas is to ask them to answer "What do you want to happen when people finish watching your video?" If students are having a hard time starting, ask them to list 3 objectives and then discuss the pros/cons. Repeat as necessary until a decision is made.
- 2) Who do they want to make the video for? Ask students to list 3 audiences they would like to show their video to. Then, ask students - why do they want to target the particular audience? What does this audience care about and how would their video address what their target audience care about? What language would they use to communicate to their audience? How would they make their video relatable to their target audience? Discuss pros/cons of suggestions. Repeat as necessary until a decision is made.
- 3) What do they want to say in their video? Small groups can utilize the "list 3 and discuss" process to generate ideas. Once a message is agreed upon, it may be helpful to consider making a thesis statement of what their message is. " Our message in this video is _____". Ideally, there is one principle message but if the purpose is broad, small groups can include 2-3 key messages.
- 4) To make their video, what are their next steps? We do not expect them to do all the planning but they should start thinking of their storyline.

Things to consider:

- a) Do they need to do more research? If so, what topics?

b) What is the storyline?

i) Will they make a storyboard? A storyboard is a sequence of drawings with some directions and dialogues that show the planned shots for a video.

ii) Will they write a script?

Will they make a shot list? A shot list shows descriptions of how a scene is shot (Wide shot, medium shot, close up) , what the framing is, what props are required, who the actors are and their dialogues.

At the end of the activity, students should have decided on

what is the purpose of their video

who their target audience is

what their message in the video is

what tasks they will accomplish in the next meeting

ACTIVITY 4: SHARE OUT VIA VLOG(ABOUT 10 MINUTES)

Small Groups

Students will create a “video diary” talking about what they have done that day and their plan for the next week of the video project. The prompt:

You will create a video diary as a way to keep track of what you have accomplished each week of the video project. You will post this on the RESET page to update RESET facilitators and students about the progress of your work. For this first week, you are to 1) say who are in your group, 2) what you did today and 3) what you plan to do next week.

FACILITATOR’S NOTE

There is a facilitation guide in the next section

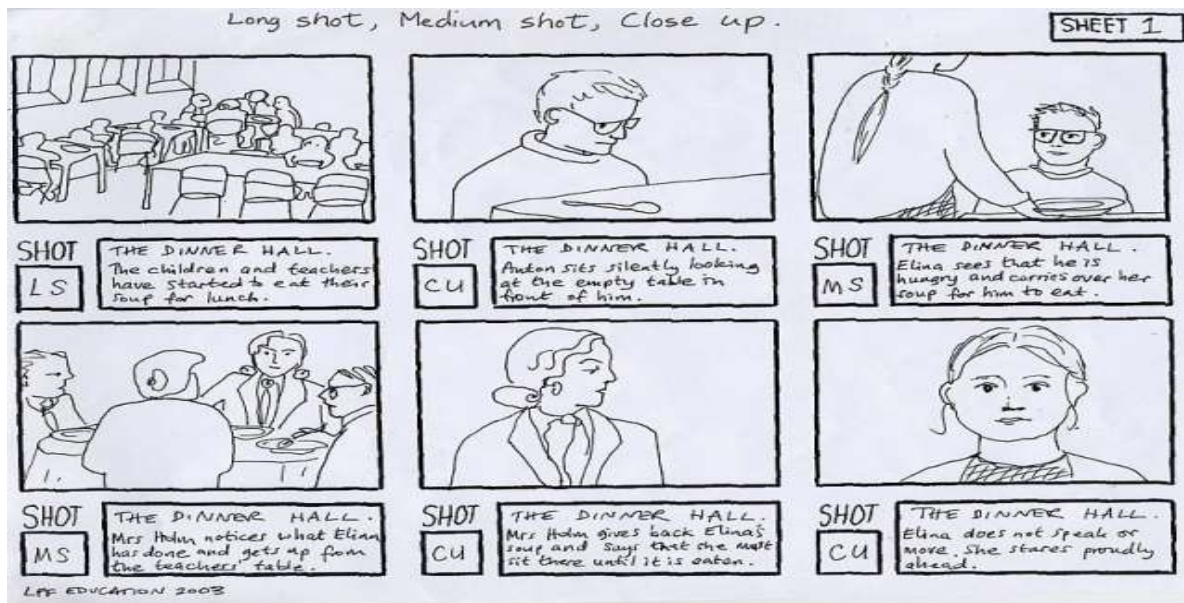
Print several copies of the Video Booklet for the different groups.

WK 18 Facilitation Guide

1. What is the purpose of the video? Small groups can discuss whether they want their video to teach their target audience/ make their target audience do something etc. A way to generate ideas is to ask them to answer “What do you want to happen when people finish watching your video?” If students are having a hard time starting, ask them to list 3 objectives and then discuss the pros/cons. Repeat as necessary until a decision is made.
2. Who do they want to make the video for? Ask students to list 3 audiences they would like to show their video to. Then, ask students - why do they want to target the particular audience? What does this audience care about and how would their video address what their target audience care about? What language would they use to communicate to their audience? How would they make their video relatable to their target audience? Discuss pros/cons of suggestions. Repeat as necessary until a decision is made.
3. What do they want to say in their video? Small groups can utilize the “list 3 and discuss” process to generate ideas. Once a message is agreed upon, it may be helpful to consider making a thesis statement of what their message is. “ Our message in this video is _____”. Ideally, there is one principle message but if the purpose is broad, small groups can include 2-3 key messages.
4. To make their video, what are their next steps? We do not expect them to do all the planning but they should start thinking of their storyline.

Things to consider:

- a. Do they need to do more research?
 1. If so, what topics? Specific questions?
 2. What are strategies for research? (e.g., online research, book reading, interviewing experts, etc.)
 3. Who would do the task?
- b. What would be a genre?
 1. Movie?
 2. Documentary?
 3. News?
 4. Music video?
- c. What is the storyline?
 1. Will they make a storyboard? A storyboard is a sequence of drawings with some directions and dialogues that show the planned shots for a video.



2. Will they write a script?
3. Will they make a shot list? A shot list shows descriptions of how a scene is shot (Wide shot, medium shot, close up), what the framing is, what props are required, who the actors are and their dialogues.

Scene #	Shot #	Location	Shot Description	Framing	Action	Dialogue	Actors	Props	Notes
1	a	Vimeo Offices - Community Pod	Matt sits at desk polishing trophy	WS (Wide Shot)			Matt	Vimeo Trophy Headpt	
1	b	Vimeo Offices - Community Pod	Matt bites Vimeo apple	MCU (Medium Close Up)			Matt	Apple	
1	c	Vimeo Offices - Community Pod	Andrea walks to Matt	MS (Mid Shot)		"Whats up?" "Walk with Me"	Matt, Andrea		
2	a	Vimeo Isle	Andrea and Matt walk and talk	Two-Shot	Dolly back as they walk	Ends with "What kind of Secret?"	Matt, Andrea		
3	a	Stairs	A + M walk down stairs	WS (Wide Shot)		"Trustworthy Employees"	Matt, Andrea		
4	a	Prow 9 - Skyline	A + M walk - skyline in foreground	WS (Wide Shot)		"I work around the clock for fun!"	Matt, Andrea		Expose Skyline
5	a	Common area	A + M eat	Two-Shot		"Guidelines tatooed on my back"	Matt, Andrea	Food	
6	a	Garage	A + M walk	WS (Wide Shot)		"I love you too Vimeo"	Matt, Andrea		
7	a	Outside Prow 3	A + M end journey outside meeting room.	Two-Shot		"Matt..."	Matt, Andrea		
7	b	Outside Prow 3	A + M end journey outside meeting room.	CU (Close Up) on Andrea		"You don't know..."	Andrea		
7	c	Outside Prow 3	A + M end journey outside meeting room.	CU (Close Up) on Matt			Matt		
8	a	Prow 3	Matt enters room	MS (Mid Shot)	M walks towards camera		Matt		
8	b	Prow 3	Vimeo Man reveal	WS (Wide Shot)	Camera dollies towards VM		Vimeo Man		Slow and Dramatic
8	c	Prow 3	VM hand clench	CA - CU (Cut Away/Close Up)			Vimeo Man		

VIDEO BOOKLET

This page is intentionally left blank. Instructions: Come up with a group name. Design your group logo/ decorate your cover page. Write down your names. When you are done, cut off these instructions. Be creative! Have fun!

What is the purpose of your video?



Who is your target audience?



What is your main message?



For next meeting, our tasks are...



LESSON 19 : VIDEO MAKING WEEK 2: WHAT'S OUR STORY?

GOALS

Think and talk about how people respond to the climate change

Lay-out a story line for the video project

MATERIALS

Computers

Reading materials

Video making booklet – (Print template for next week's task

Templates (Script, Storyboard, Shot list)

Powerpoint presentation

Markers, post-its

ACTIVITIES OF THE LESSON

ACTIVITY 1: WARM UP (ABOUT 20 MINUTES)

Whole Class

Everyone will be seated in the classroom desk with their groupmates. Pass cookies around. "today's goal is to transform the ideas that they brainstormed previously into a story.

Before doing it, I would like to show you what people say about climate change and discuss about it. Did anyone read the NY Times article that Mavreen posted? Can anyone summarize for those who have not read it?" (if no one wants to volunteer, we need to summarize it for the youth.)

"How many of you think evidence is not enough to show that man-made carbon dioxide is the cause of climate change and global warming? How many of you think that we do have enough evidence to show that? How many of you are not sure?" Ask them to write their response on a post-it note with a reason that they think either way-- *I think climate change is caused by man-made gas emission because...* Have a couple of students read their writing. "If you are not sure yet, i hope you figure this out throughout this video making process."

"There are young children who write letters to the president Trump to persuade him that climate change is caused by human activities and we need to take actions. What we are trying to do has essentially the same goal. What are things that videos can do that letters or postcards cannot do?" Hear some opinions. "we need to maximize the benefits of videos."

“Producing a video is telling a story.” Show Pixar’s video.

(<https://www.khanacademy.org/partner-content/pixar/storytelling>)

Reiterate that all of them will have different perspectives on things and that as a group they will build on those unique perspectives in crafting their video. Ask them what personal experiences can they use in crafting their video. “What was most salient about climate change to you?” Give some time for them to discuss with seatmates. Ask a student or two to share what they discussed.

Give the mini-lecture on how from those ideas they are to craft a storyline and then they can make a script/storyboard/shot list. Explain that all 3 are ways film makers keep track of what shots to take. Explain the differences of the three and tell them that they can use whatever method they think will best serve their purpose. They will have samples of all templates given to them.

ACTIVITY 2: DEVELOPING A STORY/SCRIPT/STORYBOARD/SHOT LIST (60 MINUTES)

Small Groups

Give them time to come up with their story (Slide 8). Remind them that it is a work in progress and they will keep refining it in the weeks to come. (20 minutes)

PPT Slides 9-11 (5 minutes)

Give time to work on a shotlist. (35 minutes)

When they have a working story line, have the students flesh out what things they might need to tell the parts of their story. Would they need to further research on certain topics? Have them start thinking how they will convey their message - would they use images, powerpoint presentation, shoot a scene, do an interview, look at what’s already out there, etc.

Facilitators should ensure that students understand what they are to do and let them work by themselves.

In the last 10 min, give students a reminder about the time. Have them plan out their tasks for the following week - if they have not finished their story they will continue making it. They will use post-its to write down next week’s task list that will be placed in their booklet.

Facilitators can suggest that students use the basic story segment - a beginning, a middle and an end. The *beginning* is where they hook their audience or pose their question. Have them think of ways how they can get their target audience to get interested in their video. Why should their target audience care? How would their video be relevant to their audience? The *middle* should contain their main message. Are they going to start with the big picture and support it with key messages or are they going to start with key messages to build up to the bigger picture? How will they convey their message in a way that their

audience can understand? Finally, the *end* could contain a resolution or a call to action. After watching the video, now what do they intend for their target audience to do?

ACTIVITY 3: SHARE OUT VIA VLOG(ABOUT 10 MINUTES)

Small Groups

Students will create a “video diary” talking about what they have done that day and their plan for the next week of the video project. The prompt:

You will create a video diary for what you have accomplished this week. You will post this on the RESET page to update RESET facilitators and students about the progress of your work. For this second week, you are to 0) say who are in your group (if you have new members) or talk about your group name (if you haven’t yet), 1) talk about the tentative title of your video project , 2) what you did today and 3) your plan for next week.

What do you think?

E.P.A. Chief Doubts Consensus View of Climate Change

By CORAL DAVENPORT MARCH 9, 2017

1329




Scott Pruitt, the E.P.A. administrator, spoke at an energy conference in Houston on Thursday. "The future ain't what it used to be at the E.P.A.," he said. Melissa Phillip/Houston Chronicle, via Associated Press

WASHINGTON — Scott Pruitt, the head of the [Environmental Protection Agency](#), said on Thursday that carbon dioxide was not a primary contributor to [global warming](#), a statement at odds with the established scientific consensus on climate change.

Asked his views on the role of carbon dioxide, the heat-trapping gas produced by burning fossil fuels, in increasing global warming, Mr. Pruitt said on CNBC's "Squawk Box" that "I think that measuring with precision human activity on the climate is something very challenging to do and there's tremendous disagreement about the degree of impact, so, no, I would not agree that it's a primary contributor to the global warming that we see."

RELATED COVERAGE

 E.P.A. Head Stacks Agency With Climate Change Skeptics
MARCH 7, 2017

RECENT COMMENTS

Contractor 2 days ago
When those selected to lead decide to lie, it is time to terminate them. go back to Russia with your friends.

Patrick Sorensen 2 days ago
What should we expect from a lifetime fossil fuel industry bootlicker?

RHR 2 days ago
"The planet's average surface temperature has risen about 2.0 degrees Fahrenheit since late 19th century". That is about 2 degrees F in 100...

[SEE ALL COMMENTS](#)

<https://www.nytimes.com/2017/03/09/us/politics/epa-scott-pruitt-global-warming.html? r=2>

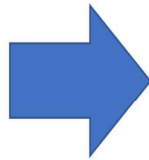
What do people and young children do to convince people?

- <http://kids4planetearth.org/1-million-letters/>
- What are some differences between letters/post-cards and videos?
- What can we do by using videos that letters and postcards cannot achieve?

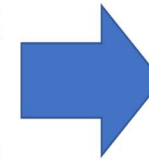
What's our goal today?



IDEA



STORY



Script

Storyboard

Shot List

Making a video is telling a compelling story.

Think about...

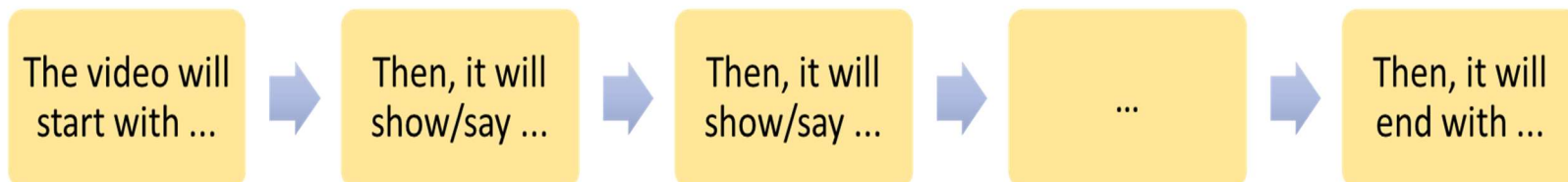
- What was most salient to you when you learned about climate change?
- Who is your audience? What might be most salient to your audience?
 - What information do you want them to take away from the video?
 - What emotions do you want them to feel during and at the end of the movie?
- What are stories that are relatable to them?

You can act on film and you can also use....

- Still images (pictures, phone photos, graphs and data, news articles, maps, etc.)
- Screen capture (you can record what you see on your computer)
 - Power Point slides
 - Videos
- Youtube videos
- Interviews with real people
- Subtitles
- Background music and sound effect
- Stop Motion Animation

Design your story!

- Decide 3-5 main messages of your story.
- Structure your video to tell those main messages.
- Don't be too broad. Focus on small and compelling pieces about climate change.



Scene List (example)

Scene Number	Visuals (videos, screen capture, pictures, graphs and data, etc.)	Audio (music, sound effect, narration, etc.)	Text	What needs to be done for this scene?
1	Polar bears lying down on an ice sheet	Cute music	Title: "Are polar bears in trouble finding ice to rest on?"	Find images of polar bears, find cute music.
2	...			
3	...			
4	Images that go along with the action items.	Say what individuals can do slow down climate change.	Subtitle: Summary of what we should do.	Research on what we can do in our everyday life, find good images
...				

If you need to act out or narrate in any scene, you will need to write a script

Describe setting, characters, and what the characters are going to do and say.

30 CONTINUED: 30

Lexa nods. The Sentry leaves. A moment later, Clarke enters alone. Lexa studies her. Indra breaks the silence...

INDRA
Where's Octavia?

CLARKE
Watching over camp.

LEXA
So tell us, Clarke. How does it end? Have you come up with a way to save your people yet again?

CLARKE
No... Only you can do that.

That stops Lexa. She's not sure what she's sensing.

CLARKE (CONT'D)
What happened here was an act of war. Your army was here to help us and my people slaughtered them. You have every right to respond. Every right to wipe us out.
(and then)
Or you can change the way you do things.

Lexa simply stares, listening, curious. Indra can no longer hold her tongue...

INDRA
Why should she change? Blood must have blood.

CLARKE
Must it?
(eyes meeting Lexa's again)
Because from where I stand the only way that ends is with everyone dead.

Lexa just keeps staring. Is Clarke reaching her?

CLARKE (CONT'D)
The question is: what kind of leader do you want to be?
(MORE)

Shot types



Weather Shot

The subject is the weather. Can be used for other purposes, e.g. background for graphics.



WS (Wide Shot)

The subject takes up the full frame, or at least as much as comfortably possible.
AKA: long shot, full shot.



MS (Mid Shot)

Shows some part of the subject in more detail while still giving an impression of the whole subject.



MCU (Medium Close Up)

Half way between a MS and a CU.



CU (Close Up)

A certain feature or part of the subject takes up the whole frame.

VIDEO MAKING RESOURCES

Resources for Video Making

<http://www.mediacollege.com/> - information about producing all forms of electronic media.

<http://www.indie-film-making.com/> - information about writing, directing, producing, and lots more related to indie filmmaking.

<https://www.shotcut.org/tutorials/> - tutorials on basic video editing skills for ShotCut

Free Sound and Music

<http://www.bensound.com/>

<http://freemusicarchive.org/>

<http://soundbible.com/>

<http://www.freesfx.co.uk/>

<https://www.soundjay.com/>

Or search for “royalty free music download.”

Free Images

<http://www.freeimages.co.uk/>

<https://stocksnap.io/>

<https://pixabay.com/>

Or search for image that you would like to find. Type a search term in the google search window and click “images.” Then, click “Settings” → “Advanced Search” and change “Usage Rights” to “Free to use or share.”

Free Videos

<https://pixabay.com/en/videos/>

<https://vimeo.com/groups/freehd>

How to Credit the Images, Videos, and Music

Read carefully the website that you download them. Some websites may want you to attribute the work to the website or author. If so, in the ending credit of your video you list all sources that you have used in your video, such as “Music: xxxx, Images: xxxxx, Videos: xxxxx.”

SCRIPT TEMPLATE

Film Title:	
Scene:	
Location:	
Character Names:	Dialogue (with stage directions in brackets)

SCENE LIST TEMPLATE

Scene Number	Visuals (videos, screen capture, pictures, graphs and data, etc.)	Audio (music, sound effect, narration, etc.)	Text	What needs to be done for this scene?

STORY BOARD TEMPLATE

<div>Scene no:_____</div>	<div>Scene no:_____</div>	<div>Scene no:_____</div>
<div>Scene no:_____</div>	<div>Scene no:_____</div>	<div>Scene no:_____</div>

LESSON 20 : EVALUATING OUR CARBON FOOTPRINT AND VIDEO MAKING WEEK 3

GOALS

Do a quick warm-up on carbon footprint

Discuss about the ethical considerations for video making

Work on video project (Research/Lay out storyline/Shoot video, etc)

MATERIALS

Computers

Reading materials

Video making booklet - template for next week's task

Powerpoint presentation

Markers, post-its

Worksheet for the Carbon Footprint Survey

Handout on the Guidelines of Ethical Video Making

Task List for Next Week

ACTIVITIES OF THE LESSON

ACTIVITY 1: WARM UP (ABOUT 10 MINUTES)

Whole Class

Welcome students. Ask them if they know what carbon footprint is. Generate ideas. Give NASA's definition and ask students what they thought could be the sources of their carbon footprint.

Have students do the survey.

Talk about the results of the carbon footprint survey. Who had the biggest footprint? Who had the smallest? Ask them what things they can do to reduce their carbon footprint (individual, family, school, community). Discuss.

ACTIVITY 2: MINI-LECTURE ON ETHICAL VIDEO MAKING (ABOUT 10 MINUTES)

Small Groups

Say, we will now shift gears to our video making. Last time we talked about how videos can be very powerful in communicating our messages. But are there ways when videos can be harmful? Ask students for ideas as to what ways videos can harm.

In making videos, we need to consider ethics - whether things are right or wrong. Discuss the following points on the slide

- 1) Make sure everyone is treated fairly (actors, interview participants, team members, etc)
- 2) Respect other people's privacy, and always ask permission when taking videos of private individuals.
- 3) Pay special attention to the rights of children and always ask permission from a parent if you include them in the videos.
- 4) Use only copyright-free materials (music, images, videos).
- 5) Give credit to all your sources (websites, newspapers, interviews, etc)

ACTIVITY 3: WORKING ON THE VIDEO PROJECT (ABOUT 60 MINUTES)

Small Groups

Students will use the time to work on their video project. If students do not remember their tasks - have them view their vlogs from WK 19 or look at their task list.

At this point some groups may be doing research, making their scripts, or shooting their videos.

ACTIVITY 4: SHARE OUT VIA VLOG (ABOUT 10 MINUTES)

Small Groups

Students will create a "video diary" talking about what they have done that day and their plan for the next week of the video project. The prompt:

You will create a video diary for what you have accomplished this week. You will post this on the RESET page to update RESET facilitators and students about the progress of your work. For this third week, you are to report what you did today and your plan for next week.

CARBON FOOT PRINT SURVEY

Source:

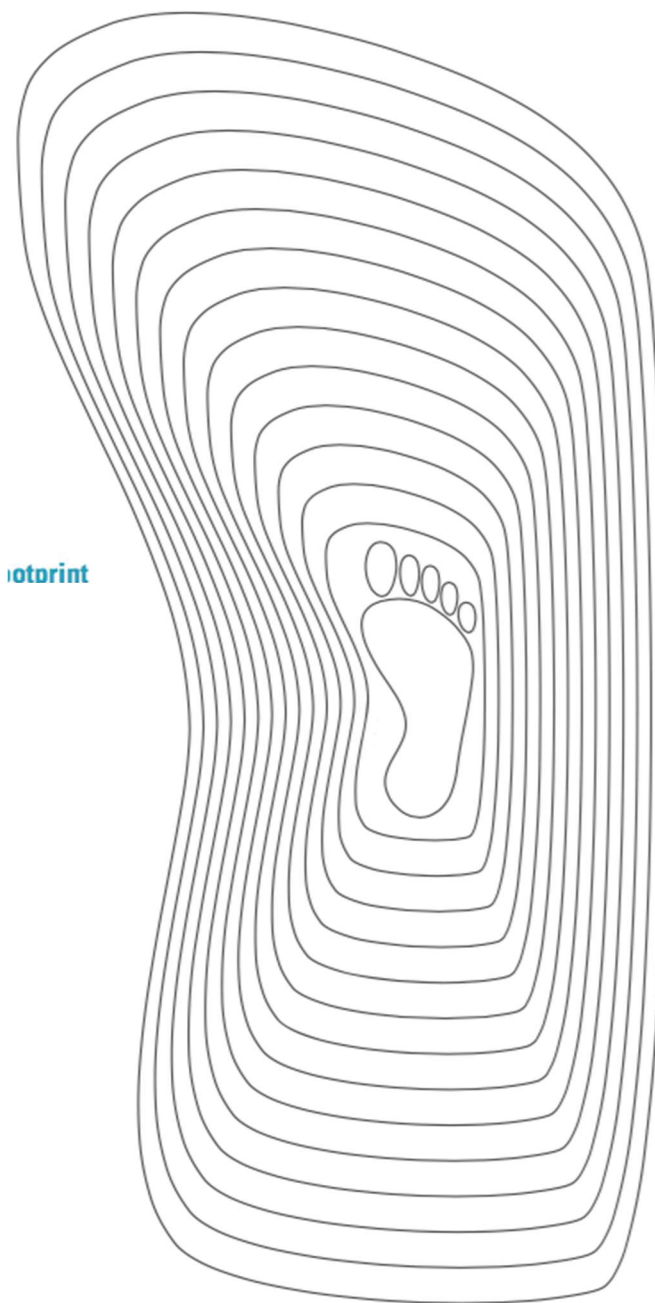
https://www.energystar.gov/ia/products/globalwarming/downloads/GoGreen_Activities%20508_compliant_small.pdf

The sun's energy drives the earth's weather and climate. The earth absorbs some of the energy and radiates (sends out) the rest back toward space. Greenhouse gases absorb some of the energy radiated from the earth and trap it in the atmosphere. A little bit of the greenhouse gases is okay because otherwise the earth would be an ice ball. But, in the past 100 years humans have created machines, factories and vehicles that have increased the amount of greenhouse gases in the atmosphere. The increased level of greenhouse gases means that more heat is trapped and the earth is getting warmer. Carbon dioxide is most important greenhouse gas. We emit carbon dioxide through our day-to-day activities. The amount we emit is referred to as our "carbon footprint." The bigger the footprint, the more carbon dioxide that comes from each of us as a result of the choices we make.

How big is your Carbon Footprint?

This survey asks a series of questions to estimate the relative size of your family's carbon footprint. There are four major areas that generate excess carbon dioxide and in this survey we represent them with different colors.

- Housing and Home Energy – RED
- Transportation – BLUE
- Personal Habits – GREEN
- Recycling Habits – BROWN



1. If you live in a single-family home, color 4 rings RED; if you live in an apartment or other type of home, color 2 rings RED.
Single-family homes generally consume more energy per resident than multifamily housing such as apartment buildings.
2. If you don't use energy-efficient light bulbs, color 1 more ring RED.
Energy-efficient light bulbs such as compact fluorescent and LED light bulbs consume less electricity than conventional incandescent light bulbs.
3. If your home doesn't have a programmable thermostat, color 1 more ring RED.
A programmable thermostat turns your home's heating or air-conditioning up and down automatically. When your home's energy system is working efficiently, it wastes less energy, thus reducing your carbon footprint.
4. If you are not familiar with the Energy Star appliance rating system, color 1 more ring RED.
Energy Star rated appliances use less energy.
5. For every small car in your family, color 1 ring BLUE.
All gasoline-powered automobiles emit carbon dioxide.
6. For every medium or large car in your family, color 2 rings BLUE.
The larger the car, the more carbon dioxide is emitted.
7. If you don't regularly change the air filter in your car and check the tire pressure, color 1 more ring BLUE.
Cars that are properly maintained are more energy- efficient.
8. For every airplane trip you've taken in the past year, color 1 more ring BLUE.
Virtually all modes of transportation consume energy, thus they impact your carbon footprint.
9. If you are a vegetarian, color 1 ring GREEN; if you are not a vegetarian, color 2 rings GREEN.
The growing, processing, packaging, delivery, and distribution of food requires energy from farms, factories, trucks, grocery stores, and more. Because a vegetarian diet does not include meat, a vegetarian tends to have a smaller carbon footprint than does a non-vegetarian.
10. If you never eat organic food, color 1 more ring GREEN.
The production of organic food puts less stress on the environment, so your carbon footprint is smaller if you tend to eat organic food.
11. If you take baths, run the faucet while brushing your teeth or washing dishes, or water your lawn several times a week, color 1 ring GREEN.
Water that goes down our drains and sewers must be processed through water treatment plants, even if the water is clean. Using only the amount of water you really need helps reduce your carbon footprint.

12. If you usually recycle your household trash, color 1 ring BROWN; if you never recycle, color 2 rings BROWN.

Recycling is good for the environment because it keeps excess waste out of landfills and trash incinerators.

13. IF you never compost your yard and kitchen waste, color 1 more ring BROWN.














Composting is good for the environment because it keeps kitchen and garden waste out of the trash and it encourages natural gardening practices. ☐

☐

☐

What are some of the ways you can reduce your Carbon Footprint

Some things we can do to reduce carbon footprint...

<p>Turn things off</p>  <p>Turn off the TV, lights, fans, and other electronics when not using them.</p>	<p>Close doors and windows</p>  <p>Keep doors and windows closed when the air-conditioning or heat is on. Hot and cold air escape quickly!</p>	<p>Shop for the ENERGY STAR® logo</p>  <p>When your family is shopping for a new TV, light bulb, appliance, or other product that uses energy, recommend that they look for products that are labeled with the ENERGY STAR logo. This means that they are certified as energy-efficient by the EPA.</p>	<p>Plant a tree</p>  <p>Trees help the environment in many ways. For one, they help clean the air by absorbing carbon dioxide and producing oxygen.</p>
<p>Unplug electronics and chargers</p>  <p>Unplug electronics and battery chargers when they are finished charging.</p>	<p>Close the refrigerator door</p>  <p>Don't leave the refrigerator door hanging open when figuring out what to eat.</p>	<p>Remember to recycle</p>  <p>Recycle paper, plastic, glass, and cans. When purchasing new items, look for ones made from recycled materials.</p>	
<p>Put your computer to sleep</p>  <p>Use the power management settings for the computer and monitor when you take a break.</p>	<p>Seal drafty spots in the house</p>  <p>Weather-strip windows and doors where there are drafts.</p>	<p>Use both sides of your paper</p>  <p>Print double-sided, and use both sides of a piece of paper before recycling it away.</p>	
<p>Use foot power</p>  <p>Walk, ride a bike, or skateboard instead of using a car.</p>	<p>Don't waste water</p>  <p>Save hot water by taking shorter showers. Also remember to turn off the water when washing dishes or brushing your teeth.</p>	<p>Share or borrow from a friend</p>  <p>The next time you want to purchase a new book or video game, borrow it from the library or a friend instead of buying a new copy. Sharing these items is a great way to reduce waste.</p>	

Source:
https://www.energystar.gov/ia/products/globalwarming/downloads/GoGreen_Activities%200508_compliant_small.pdf

Ethical Video Making: things to consider

- 1) Make sure everyone is treated fairly (actors, interview participants, team members, etc)
- 2) Respect other people's privacy, and always ask permission when taking videos of private individuals.
- 3) Pay special attention to the rights of children and always ask permission from a parent if you include them in the videos.
- 4) Use only copyright-free materials (music, images, videos).
- 5) Give credit to all your sources (websites, news papers, interviews, etc)

Source: <http://www.mywebpresenters.com/articles/2011/09/is-your-video-ethical/>

LESSON 21 : TALKING ABOUT DEFORESTATION AND VIDEO MAKING WEEK 4

GOALS

Watch a video on deforestation and discuss impacts

Work on video project (Research/Lay out storyline/Shoot video, etc)

MATERIALS

Computers

Reading materials

Video making booklet - template for next week's task

Videos on Eating Less Meat and Problem with Palm Oil,

Markers, post-its

ACTIVITIES OF THE LESSON

ACTIVITY 1: WARM UP (ABOUT 15 MINUTES)

Whole Class

Invite everyone to sit in a circle. Pass cookies around. Preface the activity by saying, "Last week, we looked at our carbon footprint and talked about some of the ways we can reduce carbon emissions." Ask students for examples of how to reduce carbon emissions and if they did anything the previous week to reduce their carbon footprint.

Then say, "We are going to watch a clip on one of the ways we can fight climate change. Then, show the video "Fight Climate Change, Eat Less Meat". While watching the video, note down on the post-it things that you found surprising.

<https://www.youtube.com/watch?v=ILhEmGx8YQE>

After watching the video, ask students to talk to their seatmates and share what they found surprising. Ask students to share ideas to the class.

If time permits, proceed to do the following:

"Several times in the last few weeks, the idea of how cutting of trees is bad for the environment has been brought up. What are some of the reasons cutting down trees is bad for the environment?" Ask students for ideas. Discuss.

Then, say "We are going to watch a clip on commercial deforestation - so these are large scale cutting down of trees. Watch the video and try to think, how did the deforestation impact the environment, animal life, and the people"

Watch the video “The Problem With Palm Oil”

<https://www.youtube.com/watch?v=LSumTLrJzdU>

After the video, ask students to talk to their seatmates and on post-it notes, write down 1 thing they learned from the video and 1 question they may have.

Discuss.

ACTIVITY 2: WORKING ON THE VIDEO PROJECT (ABOUT 70 MINUTES)

Small Groups

Students will use the time to work on their video project. If students do not remember their tasks - have them view their vlogs from WK 20 or look at their task list.

At this point some groups may be doing research, making their scripts, or shooting their videos.

ACTIVITY 3: SHARE OUT VIA VLOG (ABOUT 5 MINUTES)

Small Groups

Students will create a “video diary” talking about what they have done that day and their plan for the next week of the video project. The prompt:

You will create a video diary for what you have accomplished this week. You will post this on the RESET page to update RESET facilitators and students about the progress of your work. For this week, you are to report what you did today and your plan for next week.

LESSON 22 : HOW CLIMATE CHANGE AFFECTS POLAR BEARS AND VIDEO MAKING WEEK 5

GOALS

Watch 2017 NSF STEM Video Showcase

Watch a video on polar bears and arctic sea ice

Work on video project (Research/Lay out storyline/Shoot video, etc)

MATERIALS

Computers

Reading materials

Video making booklet - template for next week's task

Videos on how climate change impacts polar bears

Markers, post-its

ACTIVITIES OF THE LESSON

ACTIVITY 1: WARM UP (ABOUT 10 MINUTES)

Whole Class

Preface the activity by saying, "You have probably seen climate change videos that show polar bears" Then say, "We are going to watch two videos on how climate change impacts polar bears. While watching the video, note down on the post-it things that you found surprising.

Show: <https://www.youtube.com/watch?v=zahJ3I2y2bM>

<https://www.youtube.com/watch?v=rKZ009-hSu4>

After the video, ask students to talk to their seatmates and on post-it notes, write down 1 thing they learned from the video and 1 question they may have.

Discuss.

ACTIVITY 2: WORKING ON THE VIDEO PROJECT (ABOUT 75 MINUTES)

Small Groups

Students will use the time to work on their video project. If students do not remember their tasks - have them view their vlogs from WK 20 or look at their task list.

At this point some groups may be doing research, making their scripts, or shooting their videos.

ACTIVITY 3: SHARE OUT VIA VLOG(ABOUT 5 MINUTES)

Small Groups

Students will create a “video diary” talking about what they have done that day and their plan for the next week of the video project. The prompt:

You will create a video diary for what you have accomplished this week. You will post this on the RESET page to update RESET facilitators and students about the progress of your work. For this week, you are to report what you did today and your plan for next week.

APPENDIX B

RESET 2016-17

WEEK NO: _____
[Before We Leave For the Site]

Date: _____

TASK	DUE DATE	DONE	INITIALS
Curriculum for the week? Plan printed?			
Worksheets made? Printed enough copies?			
Materials for implementation gathered?			
Equipment check: Cam1, power cord, extension cord <i>Enough memory? Functioning well?</i>			
Equipment check: Cam2, power cord, extension cord <i>Enough memory? Functioning well?</i>			
Equipment check: BT mic&receiver (TOM&JERRY) connector. <i>Battery okay? Battery new as of: ____/____/____</i>			
Equipment check: Sennheiser Transmitter, Receiver, Mic, Connector, Attachment to tripod (KYO&YUKI) <i>Battery okay? Battery new as of: ____/____/____</i>			
Equipment check: Shotgun mic (SCOTT). <i>Battery okay?</i> <i>Battery new as of: ____/____/____</i>			
Equipment check: Tripod 1, Tripod 2, Wide Angle Lens			
Equipment check : Laptops charged? RESET1, RESET2, RESET3, RESET4, RESET5			
Equipment check: OLVR, OLVR1, OLVR 2, OLVR3, OLVR4 <i>Battery okay? Enough memory? Battery</i> <i>new as of: ____/____/____</i>			

[At the site]

TASK	DUE DATE	DONE	INITIALS
Picture taken of the room?			
Attendance checked?			
Folders distributed? Forms gathered?			
Materials set up?			
Equipment check: Cam1 and TOM set up as follow camera? Angle checked? Audio working? Periodic Check 10 min, 20 min, 30 min, 40 min, 50 min, 60 min, 70 min, 80 min, 90 min			
Equipment check: Cam2 and KYO set up as full capture camera? Wide Angle Lens set up? Angle checked? Audio working? Periodic Check 10 min, 20 min, 30 min, 40 min, 50 min, 60 min, 70 min, 80 min, 90 min			
Whole Class Discussion: SCOTT set up?			
Small Class Discussion: Cam 2 following MJR?			
Equipment check : OLVRs distributed to facilitators?			
Equipment check : Camtasia set up for RESET1, RESET2, RESET3, RESET4, RESET5 & Internet connected?			

[After Implementation]

TASK	DUE DATE	DONE	INITIALS
Materials gathered?			
Audio "tags" gathered?			
Student Artifacts collected or documented?			
Camtasia file saved for RESET1, RESET2, RESET3, RESET4, RESET5 ?			
Equipment check : Cam1, power cord, extension cord			
Equipment check : Cam2, power cord, extension cord			
Equipment check : TOM&JERRY			
Equipment check : KYO&YUKI , Attachment to tripod			
Equipment check : SCOTT, attachment			
Equipment check : Tripod 1, Tripod 2			
Equipment check : OLVR1, OLVR2, OLVR3, OLVR4			
Equipment check : RESET1, RESET2, RESET3, RESET4, RESET5. Computer turned off?			
Room clean? Compare with earlier photo?			

[Data Management]

TASK	DUE DATE	DONE	INITIALS
Field notes written?			
Video data transferred from Cam 1? Cam 2?			
Audio files transferred from OLVR 1? OLVR 2? TASVR1?			
Camtasia rendered?			
Other data sources?			
Data files properly named?			
Data files backed-up on External Hard Drive? MJR?			
Data files compressed and uploaded to PURR?			
Video watched and Video Content Logged?			
RESET Content Log Updated?			

<p>Name: Shen Date: 4/24/2017</p> <p>Task List:</p> <ol style="list-style-type: none"> 1) Take picture of the room before implementation. 2) Distribute audio recorders. Audio recorders stay with students. 3) Note the students who used the recorders. 4) Compare picture of the room at the end of implementation. <p>Important Conversations recorded in the Audio File</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">Recorder</th> <th style="width: 80%;">Name of Students</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">Black</td><td></td></tr> <tr><td style="text-align: center;">Blue</td><td></td></tr> <tr><td style="text-align: center;">Green</td><td></td></tr> <tr><td style="text-align: center;">Purple</td><td></td></tr> <tr><td style="text-align: center;">Yellow</td><td></td></tr> </tbody> </table> <p>Notes for this evening: (Comments, Suggestions, Future Ideas)</p>	Recorder	Name of Students	Black		Blue		Green		Purple		Yellow		<p>Name: Casey Date: 4/24/2017</p> <p>Task List:</p> <ol style="list-style-type: none"> 1) Set-up Camera 1 and BT microphone (Tom & Jerry) 2) Set up Camtasia and WiFi connection. Note the students who used the laptops. 3) Clean-up of Camera 1 and Tom & Jerry. 4) Save Camtasia 20170410_BACI1617_WK21_Screencast# 5) Record Field Notes. <p>Important Conversations recorded in the Audio File</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">I talked to:</th> <th style="width: 80%;">About:</th> </tr> </thead> <tbody> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> </tbody> </table> <p>Notes for this evening: (Comments, Suggestions, Future Ideas)</p>	I talked to:	About:								
Recorder	Name of Students																						
Black																							
Blue																							
Green																							
Purple																							
Yellow																							
I talked to:	About:																						
<p>Name: Sui Date: 4/24/2017</p> <p>Task List:</p> <ol style="list-style-type: none"> 1) Pass out cookies. 2) Audio recorders stay with students. 3) Please help the newer RESET students. 4) Clean-up. <p>Important Conversations recorded in the Audio File)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">I talked to:</th> <th style="width: 80%;">About:</th> </tr> </thead> <tbody> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> </tbody> </table> <p>Notes for this evening: (Comments, Suggestions, Future Ideas)</p>	I talked to:	About:									<p>Name: Tial Date: 4/24/2017</p> <p>Task List:</p> <ol style="list-style-type: none"> 1) Audio recorders stay with students. 2) Please help the newer RESET students 3) Clean-up. <p>Important Conversations recorded in the Audio File)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">I talked to:</th> <th style="width: 80%;">About:</th> </tr> </thead> <tbody> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> </tbody> </table> <p>Notes for this evening: (Comments, Suggestions, Future Ideas)</p>	I talked to:	About:										
I talked to:	About:																						
I talked to:	About:																						

<p>Name: Mavreen Date: 4/24/2017</p> <p>Task List:</p> <ol style="list-style-type: none"> 1) Take care of IRB forms. 2) Set-up Audio/Screen for Powerpoint presentation. 3) Set up Camera 2, Scott and, Kyo & Yuki. 4) Ensure Cam 1 and Cam 2 are capturing everyone. Periodic Checks. 5) Account for all equipment. Pack! <p>Important Conversations recorded in the Audio File)</p> <table border="1"> <thead> <tr> <th>I talked to:</th> <th>About:</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table> <p>Notes for this evening: (Comments, Suggestions, Future Ideas)</p>	I talked to:	About:									<p>Name: Minjung Date: 3/13/2017</p> <p>Task List:</p> <ol style="list-style-type: none"> 1) Set up Camera 2, Scott, Kyo & Yuki. 2) Facilitate implementation. <p>Important Conversations recorded in the Audio File)</p> <table border="1"> <thead> <tr> <th>I talked to:</th> <th>About:</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table> <p>Notes for this evening: (Comments, Suggestions, Future Ideas)</p>	I talked to:	About:								
I talked to:	About:																				
I talked to:	About:																				

APPENDIX C

1	RAW Data		Analysis Files		
2	File name	File type	Processed?	Related Files	Notes
3	Week 1		Analyzed	090116BACI1617_Analysis	
4	090116_BACI1617_Shen_AF.mp3	Audio File			
5	090116_BACI1617_Mavs_AF.mp3	Audio File			
6	090116_BACI1617_Sui_AF.mp4	Audio File			
7	090116BACI1617_WK1_Cam1.mp4	Classroom Video	MT,MR Inqscribe Log	09012016_BACI1617_WK1_Cam1_MT.Inqscr; 090116BACI1617_Cam1_MR.Inqscr	
8	090116BACI1617_WK1_Cam2.mp4	Classroom Video		090116_BACI1617_WK1_Cam2_CW.Inqscr	
9	090116BACI1617_Essays.pdf	Student Artifacts	MT Highlights of Essays	090116Week1Highlights of student essays .doc	
10					
11	Week 2		Analyzed	090816_BACI1617_WK2_Analysis.docx	
12	090816_BACI1617_Cam1.m4v	Classroom Video	MT Inqscribe Log	090816_BACI1617_Cam1_MT	
13	090816_BACI1617_Cam2.m4v	Classroom Video	MT,MR Inqscribe Log	090816_BACI1617_Cam2_MT.Inqscr; 090816_BACI1617_Cam2_MR.Inqscr; 090816BACI1617_WK2_Cam2_CW.Inqscr	
14					
15	Week 3		Analyzed	091516_BACI1617_WK3_Analysis	
16	091516_BACI1617_Cam1.mp4	Classroom Video		091516_BACI_1617_Cam1_CW.Inqscr	
17	091516_BACI1617_Cam2.mp4	Classroom Video	MT,MR Inqscribe Log	091516_BACI1617_Cam2_MT.Inqscr; 091516_BACI1617_Cam2_MR.Inqscr; 091516_BACI_1617_Cam2_CW.Inqscr	
18	091516_BACI1617_Mavs_AF.mp3	Audio File			
19	091516_BACI1617_Shen_AF.mp4	Audio File			
20					
21	Week 4		In-progress - segmented	SMD 2016_09_22 Initial Analysis.docx; 092216_BACI1617_WK4_Analysis.docx	
22	092216_BACI1617_Cam1.mp4	Classroom Video	MT Inqscribe Log	20160922_BACI1617_WK4_Cam1_MT	
23	092216_BACI1617_Cam2.mp4	Classroom Video	MT Inqscribe Log	20160922_BACI1617_WK4_Cam2_MT,	Audio of Lab portion mismatched with Camera Angle
24	092216_BACI1617_Mavs_AF1.mp3	Audio File			
25			Synced; MT Inqscribe Log	20160922_BACI1617_WK4_Cam2_MavsAF1_Sync.mp4; 20160922_BACI1617_WK4_Cam2_MavsAF1_Sync_MT	
26	092216_BACI1617_Mavs_AF2.mp3	Audio File			
27	092216_BACI1617_Sui_AF1.mp4	Audio File			
28	092216_BACI1617_Sui_AF2.mp4	Audio File			
29	092216_BACI1617_Sui_AF3.mp4	Audio File			
30	092216_BACI1617_Sui_AF4.mp4	Audio File			
31	092216_BACI1617_AirPressureWS.pdf	Student Artifacts			
32	IMG_6446.jpg	Student Artifacts			Posters on Air Pressure Experiments
33	IMG_6447.jpg	Student Artifacts			Posters on Air Pressure Experiments
34	IMG_6448.jpg	Student Artifacts			Posters on Air Pressure Experiments
35	IMG_6449.jpg	Student Artifacts			Posters on Air Pressure Experiments
36	IMG_6450.jpg	Student Artifacts			Posters on Air Pressure Experiments
37					

RESET Field Notes

RESET Classroom Data

RESET Interview Data

Youth Videos

2016-17Summary of Interviews

Pseudonyms



APPENDIX D

Excerpt of RESET 2016-17 year-long event map

RESET (SY 2016-2017)			
Week No.	Date	Lesson Objective	Learning Activities
1	9/1/2016	What are our weather experiences?	Learners discuss about weather experiences using weather pictures.
2	9/8/2016	What are the weather variables? I	Learners manipulate half-cut water bottle as demonstration for air pressure. They read/discuss/fill out a reading material with their small group.
3	9/15/2016	What are the weather variables? II	Learners continue to work on reading material. Learners discuss the reading in the whole group. They manipulate Galileo's thermometer.
4	9/22/2016	What is air pressure?	Learners do 4 different air pressure experiments with small group. They draw about the mechanism of the experiment and explain it without using "air pressure".

VITA

MAVREEN ROSE STA. ANA TUVILLA

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560 Oval Drive
West Lafayette, IN 47907-2084

EDUCATION

- PhD** Purdue University, Chemistry (Chemistry Education) May 2020
Dissertation: “Multimodal analysis of minoritized learners’ science engagement in an afterschool science program”
Advisor: Minjung Ryu
- MS** Texas A&M University, Chemistry May 2013
Thesis: “Enzymatic digestion in aqueous-organic solvents: A mass spectrometry-based approach in monitoring protein conformation changes”
Advisor: David H. Russell
- BS** University of San Carlos (Philippines), Chemistry March 2004
Thesis: “Effect of Ethanol on Blood Detection Time of α,α - dimethylphenethylamine in Albino Rats (*Rattus norvegicus*)”
Advisor: Ramon S. del Fierro
Graduated Magna Cum Laude

AREAS OF SPECIALIZATION/AREAS OF RESEARCH INTEREST

Education: Science education, Ethnography, Video analysis, Multimodality, Refugee Education
Chemistry: Analytical Chemistry, Mass Spectrometry, Proteomics

RESEARCH EXPERIENCE

Education

LETS Science: Language-Enhanced Teaching in Superdiverse High School Science Classrooms

Principal Investigator: Minjung Ryu

Funding Source: National Science Foundation, DRK-12 (NSF 1813937)

Award: \$847, 245

Roles: Grant proposal: conceptualization and writing

Research: planning, data collection, training of junior research members

Dissertation, Purdue University

RESET: Refugee Youth Engaging in Critical STEM Literacy

Principal Investigator: Minjung Ryu

Funding Source: National Science Foundation, AISL (NSF 1612688)

Role: Research: planning, data collection/analysis/management; project management

Chemistry

Russell Labs, Texas A&M University 2011 to 2013
Research and Service Lab Assistant, David H. Russell
Specialized in protein separations and mass spectral analysis

Vigh Labs, Texas A&M University 2009 to 2010
Research Assistant, Gyula Vigh
Specialized in high performance liquid chromatography and organic synthesis

TEACHING EXPERIENCE

Purdue University, West Lafayette, IN Aug 2015 to May 2016

Teaching Assistant, Department of Chemistry

- Taught CHM 111, an undergraduate general chemistry course for allied health sciences students
- Taught CHM 200, an undergraduate general chemistry course for elementary education majors
 - Revised the lab manual and aligned them to Indiana Science Standards

BASIS Flagstaff, Flagstaff AZ

Aug 2013 to May 2015

Teaching Assistant, Department of Chemistry

- Taught 8th grade chemistry
 - Developed materials to prepare students for BASIS district-wide cumulative examination
 - Raised cumulative exam passing grade from 49% to 70%
 - Revamped lecture and laboratory curriculum
- Taught Honors and AP Chemistry
 - Created the syllabus and developed materials to prepare students for the AP exams
 - Students' scores averaged 3.5 in 2014 and 4.5 in 2015

Texas A&M University, College Station, TX

Aug 2009 to May 2013

Teaching Assistant, Department of Chemistry

- Taught CHM 318, an undergraduate quantitative analysis chemistry course
- Taught CHM 434, an undergraduate instrumental analysis course for chemistry majors
 - Revised the lab manual

University of San Carlos, Cebu Philippines

Jun 2004 to March 2005

Assistant Instructor, Department of Chemistry

- Taught CHM 114, an undergraduate general chemistry course

OTHER WORK EXPERIENCE

Bank of the Philippine Islands, Bacolod, Philippines

Aug 2005 to Jun 2009

Assistant Manager

- Service officer for a commercial bank
- Managed and trained 5 staff
- Managed the cash-on-hand, ATM, and accountable forms

PUBLICATIONS

Journal Publications

Ryu, M., & **Tuvilla, M. R. S.**, & Wright C.E. (2019). Resettled Burmese Refugee Youth's Identity Work in an Afterschool STEM Learning Setting. *Journal of Research in Childhood Education*, 33(1), 84-97.

Ryu, M., & **Tuvilla, M. R. S.** (2018). Resettled Refugee Youths' Stories of Migration, Schooling, and Future: Challenging Dominant Narratives About Refugees. *The Urban Review*, 50(4), 539-558.

Tuvilla, M. R. (2017). Sacrificing Families: Navigating Laws, Labor, and Love Across Borders. *Multicultural Perspectives*, 19(4), 1-8.

Conference Proceeding

Tuvilla, M.R., Wright, C.E., Ryu, M., & Daniel, S.M. (2018, June). How Do Multilingual Learners Support One Another's Science Learning and Participation? *2018 Proceedings of the International Conference of the Learning Sciences*, 1761-1762. London, UK

INVITED TALK

Tuvilla, M.R. (2018, June). Multimodal Interactional Analysis of Youth Interactions in an Afterschool Science Learning Setting. Sheffield Hallam University, Sheffield, UK.

CONFERENCE PRESENTATIONS

International and National Conferences

Wright, C.E., **Tuvilla, M.R.** & Ryu, M. (2018, July). Identity work of resettled Burmese refugee youth in an afterschool STEM program. 25th Biennial Conference on Chemical Education, Notre Dame, IN.

Tuvilla, M. R., & Wright, C. E. (2018, June). How do multilingual learners support one another's science learning and participation? Poster presented at the 13th International Conference of the Learning Sciences, London, UK.

Tuvilla, M. R., & Wright, C. E. (2018, June). How do multilingual learners support one another's science learning and participation? Poster presented at the NSF- sponsored Early Career Cross-Community Poster Event. Festival of Learning, London, UK.

Tuvilla, M. R. & Ryu, M. (2018, April). Multimodal Interactional Analysis of Youth Interactions in an Afterschool Science Learning Setting. Paper presented at the Annual meeting of the American Educational Research Association, New York, NY.

Ryu, M., **Tuvilla, M. R.**, & Wright, C. (2018, March). Examination of Burmese Youth's Participation and Identity Work in a Community-based Science Program. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Atlanta, GA.

Ryu, M., Sikorski, T. R., & **Tuvilla, M. R.** (2017, June). A multimodal analysis of group collaboration: What does equitable and inequitable collaboration look like? Paper presented at the Association for Visual Pedagogies Conference, Aalborg, Denmark

Ryu, M., **Tuvilla, M. R.**, & Wright, C. E. (2017, May 14). Creating Spaces With Resettled Refugee Youth [Video file]. Retrieved May 16, 2017, from <http://stemforall2017.videohall.com/presentations/994%20>

Ryu, M., **Tuvilla, M. R.**, & Wright, C. (2017, April). Burmese refugee youth's identity work in an after-school learning setting. Paper presented at the annual meeting of the American Educational Research Association, San Antonio, TX.

Tuvilla, M. R. & Ryu, M. (2017, April). Resilience in the moment: Refugee youth's resilience in science learning setting. Paper presented at the annual meeting of the American Educational Research Association, San Antonio, TX.

Tuvilla, M. R. & Ryu, M. (2017, January). What can K-12 teachers learn from minoritized youth's interactions in an afterschool science program? Paper presented at Indiana STEM Education Conference, West Lafayette, IN.

Ryu, M. & **Tuvilla, M.R.** (2016, April). Critical STEM literacy practices among resettled Burmese refugee youth. Paper presented at the annual meeting of the American Educational Research Association, Washington, DC.

Regional Conferences

Tuvilla, M. R. (2019, February). Multimodal Analysis of Minoritized Learners' Science Engagement in an Afterschool Science Program. Paper presented at the Ethnography in Education Research Forum, Philadelphia, PA.

Tuvilla, M. R., Wright, C. E., & Ryu, M. (2018, March). Analysis of Multilingual Learners Interactions in an Afterschool Science Program. Poster presented at the Annual Graduate Students Educational Research Conference.

Tuvilla, M. R., Wright, C. E., & Ryu, M. (2018, March). Analysis of Multilingual Learners Interactions in an Afterschool Science Program. Poster presented at the 3rd Annual Purdue Linguistics, Literature, and Second Language Studies Conference.

Wright, C. E., **Tuvilla, M. R.**, & Ryu, M. (2018, January). Multimodal Interactional Analysis for Analyzing Participation in Informal Learning Settings. Paper presented at the 3rd Annual Indiana STEM Education Conference, West Lafayette, IN.

Tuvilla, M. R., Wright, C. E., & Ryu, M. (2017, March). Burmese Youth's Identity Negotiation in an Afterschool STEM Program. Poster presented at the Annual Graduate Student Education Research Symposium, West Lafayette, IN.

Tuvilla, M. R. & Ryu, M. (2016, October). Betty's resilience in the moment: Refugee Youth's 'Hidden' Resilience in an Afterschool STEM Program. Paper presented at Learning Sciences Graduate Students Conference, Chicago, IL

Tuvilla, M. R. & Ryu, M. (2016, January). Responsive teaching: A way to engage transnational students in science talks. Paper presented at Indiana STEM Education Conference, West Lafayette, IN.

FELLOWSHIPS, AWARDS, AND MENTIONS

NAEd/Spencer Dissertation Semi-finalist. (2019, February). National Academy of Education/Spencer Dissertation Fellowship Program. *Selected as one of the 61 semi-finalists from a group of 420 highly qualified applicants from 121 graduate institutions.*

Women in Science Programs Travel Grant. (2018, December). Purdue University College of Science Diversity Office. *Total Funding Granted: \$500*

Community for Advancing Discovery Research in Education (CADRE) Fellow 2018-2019. National Science Foundation Discovery Research preK-12 (DRK-12).

AERA Division C Graduate Student Mentoring Seminar Attendee. (2018, April). American Educational Research Association Division C. *Total Funding Granted: \$300*

PGSG Travel Grant. (2018, May). Purdue Graduate Student Government and the Graduate School. *Total Funding Granted: \$500*

Best Poster for Completed Research. (2018, March). **Tuvilla, M.R. & Wright, C.E.** 2018 Annual Graduate Students Educational Research Conference, Purdue University, West Lafayette, IN.

NSF STEM For All 2017 Public's Choice Award. Ryu, M., **Tuvilla, M. R., & Wright, C. E.** (2017, May 14). Creating Spaces With Resettled Refugee Youth [Video file]. Retrieved May 16, 2017, from <http://stemforall2017.videohall.com/presentations/994%20>

Best Poster for In-Progress Research. (2017, March). **Tuvilla, M.R. & Wright** 2017 Annual Graduate Students Educational Research Conference, Purdue University, West Lafayette, IN.

Ross Fellowship (2015-2016). Purdue University Graduate School. *Total Funding Granted: \$28,714*

COMMUNITY SERVICE

Klondike Robotics Team STEM

[Robotics Judge], [Klondike Elementary School], January 2016, January 2018

National Chemistry Week

[Volunteer], [Purdue University], October 2015, October 2016

[Volunteer], [Texas A&M University], October 2013

Expanding Your Horizon

[Facilitator], [Purdue University], October 2015, October 2016

Phi Lambda Upsilon Chemistry Honors Society

[Member], [Purdue University], 2015- present

[Treasurer], [Texas A&M University], 2011-2012

Iota Sigma Pi Honors Society

[Member], [Purdue University], 2015- present

Women in Science

[Member], [Purdue University], 2016- present

TECHNICAL SKILLS

Education

Software Packages: : Transana, Nvivo, Camtasia, InqScribe, Handbrake

Chemistry

Instrumental Analysis: HPLC, MS (MALDI, ESI, FTICR, STR), GC, IC, GC-MS, LC-MS, UV-Vis, FTIR, AAS, CE, Fluorescence Spectrophotometry, XRF, DSC, CD

Proteomics Protocols: SDS-PAGE, ITRAQ labeling

Software Packages: SciFinder, 4000 Peak Explorer, Protein Pilot, GPS Explorer

PUBLICATIONS



Journal of Research in Childhood Education



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Resettled Burmese Refugee Youths' Identity Work in an Afterschool STEM Learning Setting

Minjung Ryu, Mavreen Rose S. Tuvilla & Casey Elizabeth Wright

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To link to this article: <https://doi.org/10.1080/02568543.2018.1531454>



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Resettled Burmese Refugee Youths' Identity Work in an Afterschool STEM Learning Setting

Minjung Ryu, Mavreen Rose S. Tuvilla, and Casey Elizabeth Wright

Purdue University, West Lafayette, Indiana

ABSTRACT

Youth from nondominant racial and linguistic backgrounds often have limited access to school science learning opportunities. Afterschool settings may provide learning environments in which they improve science knowledge and construct positive science identities. With this premise, our research team designs and provides a community-based afterschool program that engages resettled Burmese refugee youth in Science, Technology, Engineering, and Mathematics (STEM) learning. In this article, the authors seek to understand how refugee youth utilize their funds of knowledge and what identities were foregrounded in the program. The authors adapt a microethnographic perspective in their research and review video recordings of participants' engagement through multimodal discourse analysis. Their analysis suggests that youth crafted creative ways to participate in the science discourse, such as (1) blending joking and laughter with science discourse to negotiate their identities with each other and with an otherwise intimidating discourse, (2) utilizing place-based ethnic practices and knowledge in participating in science discourses, and (3) coordinating turn taking and responding to others' ideas that makes the learning environment safe and inviting to all. The authors discuss insights that can potentially advance our understanding of refugee youth identities and transform our ways of supporting their science learning.

ARTICLE HISTORY

Received 7 March 2018
Accepted 21 August 2018

KEYWORDS

Funds of knowledge;
identity; informal STEM
program; resettled Burmese
youth; science discourse

With an increasing number of refugees resettling in the United States, research to examine and support refugee youth's learning of various science disciplines has become a high priority in formal (Banner, 2016) and informal education environments (Tan & Faircloth, 2017). Many school-age refugee youth are emergent multi- or bilinguals, labeled as English language learners (ELLs) in school settings. ELLs are often marginalized in schools (Gutiérrez, Larson, & Kreuter, 1995), and refugee youth have limited access to high-quality science classes because of tracking that prioritizes remedial English language development over rigorous disciplinary learning (Kanno & Kangas, 2014). Moreover, despite the interruption to formal schooling that many resettled refugee youth experience, they are often enrolled in grade level on the basis of age rather than academic competency. Or they join newcomer programs where they learn basic literacy and mathematics skills with other newly arrived immigrants and refugees (Capps et al., 2015; Ruiz-de-Velasco & Fix, 2000). Thus, there is a critical need to provide better support for disciplinary instruction that offers resettled refugee students with opportunities for science learning.

Here, we pose a question in operationalizing this seemingly obvious educational aim as to what specific science education goals should be pursued for refugee youth and how to prioritize these goals. Science education reform documents (e.g., Next Generation Science Standards) set two different but important goals: increasing literacy among all students and educating young students to pursue science majors in postsecondary education that lead to careers in the science workforce. Although acknowledging the importance of developing future workforce and potential financial benefits that science and STEM would bring to resettled refugee youth, we are also concerned about

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those who do not necessarily intend to pursue science as postsecondary careers, are marginalized in and alienated from science discourses, and may see science as irrelevant to their own lives. Thus, in science education for resettled refugee youth, we are interested in pursuing ways to engage them in science discourse that is relevant to them, has an impact on their present and future lives, and contributes to changes toward social justice in the immediate and larger society. In what follows, we elaborate on our theoretical framework, building on funds of knowledge (Moll, Amanti, Neff, & Gonzalez, 1992). Then, we show our analysis of data collected from a community-based afterschool STEM program that is designed to pursue aforementioned goals and demonstrate how resettled Burmese youth engaged in such science discourse drawing on their unique and various funds of knowledge. Based on the findings, we aim to provide implications for best practices in STEM education for disadvantaged populations more broadly.

Theoretical framework

Science has been taught traditionally in a “mono-methodological” manner, in that its objectivity and empiricism are overemphasized over creativity and subjectivity (McFarlane, 2013). Teachers are the ones who decide what knowledge is legitimate and relevant and who has agency and authority in each instructional moment. In this science teaching tradition, students are inhibited from agentively deciding what is relevant to their learning but are expected to acquire knowledge selected by the teachers and constrained to limited opportunities in their participation in classroom decisions (Calabrese Barton, Basu, Johnson, & Tan, 2011). This tradition has marginalized students, particularly those from racially, culturally, and linguistically nondominant backgrounds (Aikenhead & Jegede, 1999). The practices, discourses, and knowledge that science teachers employ in the teaching of science are often a mismatch with what nondominant students bring to bear to science learning contexts. Thus, their experiences, values, and ideas are not appreciated as valuable resources for learning science and are even penalized as impeding new learning.

Recently, many science educators have challenged this conventional view of science teaching and learning and striven to incorporate students’ everyday experiences, practices, and values to foster their science learning and the construction of positive identities as science learners. By employing students’ “funds of knowledge” as valuable assets for new learning, educators have designed classroom learning environments in which racially and linguistically nondominant students can achieve robust science learning. Although funds of knowledge were originally understood as home-based knowledge (Moll, Amanti, et al., 1992), recent research has expanded its scope into the broader public sphere. These individuals bring a fund of complex experiences to our public environments, such as transnational experiences of immigrant students and youth pop culture (Moje et al., 2004), skills and talents in various activities such as storytelling that are not often sanctioned in traditional science classes (Tan & Calabrese Barton, 2008b), knowledge learned from the streets and students’ ethnic communities (Calabrese Barton, Tan, & Rivet, 2008), and their nonscholastic labor experiences (e.g., working in a barber shop, drum playing; Seiler, 2001). What is common in all of the studies cited here is the realization that teachers, rather than being the sole transmitters of knowledge, are actually interacting with students already adept at a range of skills and discourses to which the teachers would be novices. Thus, learners are positioned as “important and powerful participants in their own learning and that of their peers and teachers, and also as members of a larger global society who can leverage their lives in schools towards making a change” (Calabrese Barton et al., 2011, pp. 6–7).

Afterschool and community-based programs constitute middle grounds where learners can engage STEM subject matters with fuller utilization of the funds of knowledge they bring with them (O’Neill, 2011; Rahm, 2013). The free use of nonschool practices and knowledge along with school-based knowledge can afford democratic education aimed at mitigating the existing asymmetric power relations in school science. Examples are numerous: an urban afterschool science program that has expanded funds of knowledge to include students’ visions for their futures, social relationships, and their own purposes and use of science (Basu & Calabrese Barton, 2007);

a program offered for Latino youth that draws on the culture, language, and practices of the Latino community and advocates for investigating these funds by engaging the community in dialogue about the education in their schools (Fairbanks et al., 2017); a community-based program that engaged learners of indigenous communities in learning about climate change that combines traditional stories, climate change science instruction, and performances (McGinty & Bang, 2016); and an after-school video project that advanced learners' perception of science to incorporate their neighborhoods and everyday knowledge from the people who lived there (O'Neill, 2011). Informal learning opportunities gain more attention not only as an auxiliary delivery for science learning but also for advancing critical and democratic science learning experiences of students who are underserved in school science (Hodson, 2003). These afterschool programs are successful because they offer opportunities for students to blend a wide range of their out-of-school practices with the practices and knowledge they acquire in the afterschool space.

This study builds on the line of research that aims to foster science learning of youth who are minoritized in school due to their racial, cultural, and linguistic affiliation. In particular, this study focuses on a community-based afterschool program that serves high school youth of resettled Burmese refugee backgrounds. Utilizing interviews collected from the Burmese youth (Ryu & Tuvilla, 2018) and building on existing literature about resettled Burmese refugee backgrounds (Barron et al., 2007) and practices (Duran, 2016), we designed and implemented an afterschool program that engages the youth in learning and talking about science, specifically the topic of weather, climate, and climate change. We hoped the youth participants would leverage their funds of knowledge to the maximum extent possible, in the doing and the discourse about science. We agree that teachers who explicitly invite students' home knowledge are successful in incorporating funds of knowledge into the classroom setting (Calabrese Barton & Tan, 2009). In particular, we believe that funds of knowledge in a broader sense include learners' previous and current experiences in the wider public sphere (e.g., Calabrese Barton et al., 2008; Moje et al., 2004; Seiler, 2001; Tan & Calabrese Barton, 2008a). To encourage youth participants to bring various funds of knowledge, we provided opportunities to share their experiences and stories, draw on youth culture, and use their home languages. By engaging with familiar discourses in science settings, students can incorporate familiar experiences and examples from their lives to make science relevant and accessible to them (Lin & Wu, 2015). Especially for ELLs, home language practices in conjunction with science allow them to develop new science discourses by accessing the knowledge they have developed in all of their language repertoires.

In doing this work, we were not motivated by the argument for science education that defines its primary goals as economic growth and global competence of the country (Hodson, 2003). Rather, we were interested in fostering critical science literacy (Tan, Calabrese Barton, Gutiérrez, & Turner, 2012) wherein youth construct purposes and uses of learning science, potentially to transform discourses and practices of science (e.g., Upadhyay & Albrecht, 2011), their identities (e.g., O'Neill, 2011), and the world around us to build democratic and just societies (e.g., Emdin, 2011).

During the implementation of this program, we collected data through ethnographic means to examine how the participants engage in collaborative scientific sense making and, in doing so, how they utilize various funds of knowledge and negotiate identities. Specifically, we asked

- What kinds of funds of knowledge did the Burmese youth utilize in STEM afterschool program?
- Through discursive participation in scientific sense making, how did they negotiate identities?

Methods

This study is situated within a large research project, Project RESET (Refugee Youth Engaging in Critical STEM Literacy and Learning), that was part of a community-based afterschool program

offered for Burmese high school youth in a midwestern city in the United States. The afterschool program is provided by a Burmese community organization with the aims of educating Burmese youth to increase their college enrollment rates, achieve skilled position job placement, and integrate the Burmese community into the local communities. The afterschool program met at the high school that roughly one half of the youth participants attended for their public schooling.

An average of 10 to 20 teens, who were sophomores and juniors in high school at the time of this study, attended each session of Project RESET. Most youth participants were ethnically Chin, one of the major ethnic groups in Myanmar. However, as the Chin youth came from various subethnic groups, they spoke multiple Chin languages (e.g., Hakha, Falam, Zophei), which were not mutually intelligible. The length of time spent in the United States at the time of the program varied greatly, as did their English language proficiencies. Prior to their migration to the United States, participants had migrated to an initial asylum country where they had spent anywhere from a few months to several years. At the time of the program, some participants had recently migrated to the United States, whereas others had resided in the United States for up to 10 years.

In 2015 and 2016, one of every three afterschool sessions were designed and implemented by the Project RESET team (21 Project RESET sessions overall, one-and-half hours per each session). Learning activities included whole-group and small-group discussions, poster presentations, online research, essay writing, and experimentation. In designing and implementing the curriculum, we drew on a responsive curricular approach (Hammer, Goldberg, & Fargason, 2012) wherein facilitators accessed and built upon learners' contributions, allowing them to pursue their interests within broader curricular goals. This approach enabled us to draw from and build on learners' everyday experiences and funds of knowledge (Moll, Amanti, et al., 1992). We used English to communicate via materials in the program but encouraged students to use their home languages. Learners were encouraged to use their full linguistic repertoires to make sense of STEM ideas collaboratively with peers who speak different home languages and were provided authentic reasons to produce more extended output (Swain, 1985).

The first and second authors facilitated each session and collected data. In our data collection, we take a microethnographic approach that "focus[es] on specific behavioral interactions in specific institutional settings, and do not attempt to describe a whole way of life" (Moll, Diaz, Estrada, & Lopes, 1992, p. 341). Our focus was on how resettled Burmese youth collaboratively made sense of STEM ideas in an afterschool STEM program. Accordingly, we collected data that included video- and audio-recordings of sessions, interviews, screencasts of participants' computer use, participant-generated artifacts, and field notes. Two video cameras were installed at two corners of the classroom to capture each session in its entirety. When the participants were engaged in group activities, we placed voice recorders on a table close to participants' groups to capture the small-group discussions. We also collected videos of participants' computer usage through screencasting, using Open Broadcaster Software, when they were engaged in online research. Finally, we digitized artifacts that youth generated in each session, such as chart paper and worksheets, by taking digital photos or scanning them.

Our numerous data sources provided material for rich and multilayered analysis of the patterns and practices of the afterschool setting (Baker, Green, & Skukauskaite, 2008). In analyzing this large archive of data, we draw on video analytic techniques suggested by Derry et al. (2010) and Knoblauch and Schnettler (2012). The three authors of this article individually watched unedited video recordings to understand the flow of each session, segmented each session based on activity structures (e.g., small-group discussion, whole-group discussion, presentation) and topics and created a video log file, and selected events—an analytic unit that is composed of several discursive turns, deals with a coherent topic, and has its own flow (i.e., start-development-end or switch to another topic)—for a close analysis. After watching each week's video individually, we met as a group to discuss individual sense making. In this meeting, we determined the segmenting of each session and cowatched individually chosen events to discuss emerging interpretation with respect to the funds of knowledge and discursive negotiation of identities. After each meeting, we constructed a

video log file using Microsoft Excel that documents each segment, its start and end time, and a brief description of each segment, including its activity structure and topic. Each session consisted of five to 10 segments. We then developed a separate word document for analytic notes of selected events. In the analytic notes, we described the details of the selected events including utterances, paraverbal and nonverbal features of discourses, and arrangement of material resources (e.g., paper, computer), wrote interpretations of each event, and recorded emerging keywords (e.g., joking, word play, power dynamics, giving space, Chin practices). To situate selected events within the larger context of the program, we inserted the selected events (e.g., title, keywords) under corresponding segments in the video log file. The analysis process was dynamic and iterative, in that we constantly revisited our interpretation as new insights came up and challenged each others' interpretation by suggesting alternative interpretations and providing evidence from our other data sources. Simultaneously, we looked across the emerging keywords to determine how consistently they show up in our analytic notes and identify upper-level themes.

In this article, we analyzed classroom video- and audio recordings collected in Weeks 1 through 5, roughly the first quarter of the one-year program. In the early weeks of a learning setting, learners have not yet developed participatory norms of a setting (Mercer, 2008; Yackel & Cobb, 1996). Instead, they bring their expectations and practices from other similar settings and test them to negotiate norms of this new learning setting. Thus, we believe that this early period is especially useful for observing learners' diverse funds of knowledge and identity negotiation that has not yet been settled and is still rough. In addition, this early period is critical to planning how to maximize the use of identified funds of knowledge for the rest of the program. Thus, in the Findings section, we present three themes that we identified in the analysis of the multiple events selected from the first five weeks' data.

Findings

Throughout the first 5 weeks, we observed that participants perceived Project RESET to be an extension of school science, as evidenced by the ways they participated in various learning activities. For instance, they utilized practices, knowledge, and norms that seemed to be learned in school science classes to participate in and contribute to the discussions. When explaining variables to describe weather phenomena, a couple of participants mentioned "water cycle" or "water cycle thing-y" by drawing it on the chart paper or with a finger circling in the air. Despite the use of this scientific term, they did not clearly articulate how water cycle is related to the phenomena discussed in the moment. In addition, students called on each other for not being "scientific" and at times obliged peers to use school-sanctioned terminology or offer logical evidence to support their claims. Use of incorrect terms was readily noticed and fixed by peers as well (e.g., condensation, hurricane, tsunami). When the youth presented their ideas, they stood up and walked to the front of the room to present their group's ideas, even when they were not prompted to do so. When presenting in his or her own seat, the speaker would turn toward the facilitator (Minjung) as if to seek approval of their ideas. Some participants appeared to invoke their science and/or academic identities that have been established in school in positioning themselves within Project RESET. One participant, who seemed to be less engaged in the program's learning activities and had a relatively lower English proficiency, said "Science is so hard ... I don't have idea ... I got always a D or a C ... I think this is not my subject."

We believe that these behaviors were due to the students' association of the after-school programming with conventional norms of schooling in general. They were, after all, in the classroom space in which they learned these models and seated at school classroom tables. In other sessions of the afterschool program, the youth obtained help in school homework and college application from other volunteers. In addition, we also employed typical school class activities, such as the use of Powerpoint slides and worksheets as learning activities. Although the youth brought these norms and perceptions about science learning from school spaces, we did see students begin to adapt to the more fluid opportunities offered by the researchers to engage outside classroom conventions. Youth crafted creative ways of participating in and contributing to the science discourse. In the following

episodes, we summarize three salient ways in which the youth engaged in science discourse: (1) blending joking and laughter with science discourse to negotiate their identities with each other and with otherwise intimidating discourse, (2) utilizing place-based ethnic practices and knowledge when participating in science discourses, and (3) coordinating turn taking and responding to others' ideas in a way that makes the learning environment safe and inviting to all.

Theme 1: Youth blended joking and laughter with scientific discourse

From the early weeks in the program, joking and laughter were prevalent. Joking fosters solidarity and group membership through the establishment of a shared understanding (Davies, 2003). Joking involves a transition in the interpretive frame from a "world of the ordinary conversation into a world of play or non-seriousness" (Davies, 2003, p. 1367). Davies argued that joking can be utilized to relay ideas that can easily be denied ("But I was only kidding; can't you take a joke?"; Davies, 2003, p. 1367). Thus, joking can afford learners a way to share ideas they are uncertain of without fear of embarrassment. In Project RESET, the youth participants frequently interwove jokes and scientific discourse. By doing so, the youth seemed to accomplish at least two discursive goals: crafting space to communicate ideas with less fear about embarrassment and challenging each other's ideas in a less threatening way. Thus, the youth negotiated their identities (e.g., funny person) with each other and engaged in science discourse that may potentially be intimidating, especially when they are uncertain about their ideas.

Here, we describe an example of how youth participants engaged in collaborative joking. In Week 5, the youth were trying to answer Neo's question on whether dew would form on a flying airplane. They spent about 15 minutes discussing possible answers in their self-selected small groups. They then sat in a circle and took turns sharing their ideas. Several groups had already shared their ideas and it was Tom and Paul's turn to share their ideas:

Tom and Paul are close friends and their supportive relationship is evident in their bodily movements that seemingly support each other in Turns 1 and 2. In Turn 2, Tom sets the stage for Paul's performance by introducing Paul as his "Uncle Bob and brother." This moment was interpreted as a playful moment, marked by the youth's loud laughter. In Turn 4, Paul cleared his throat as part of his performance of the scientist character, but this was not yet obvious to the whole group. In the same turn, Paul's utterance of "The Tom-Paul theory" coupled with his bodily movement as if he was waiting for the audience's reaction indicated that Paul was framing his performance of a scientist character as a joke. His naming of their idea as "The Tom-Paul theory," which emulated scientific theories named after contributing scientists (e.g., Darwin's theory of evolution), elicited group laughter; everyone entered the playful frame Paul had set. In Turn 6, Paul elaborated his performance of the scientist character by saying, "We strongly believe," instead of a more typical introduction, such as, "We think." By embellishing his speech with a voice that other participants understood to be a self-assured, but comically wrong, voice of science. In Turn 7, Chit corrected Paul's use of "believe" with "hypothesize." Her comment seemed to draw on the dominant science discourse they must have learned in school (Tan & Calabrese Barton, 2008a). Yet she simultaneously exhibited her understanding of Paul's joke and showed her support to keep the joke going, rather than genuinely criticizing him. This is evidenced by her laughing tone in Turn 7.

In this excerpt, Paul stated his and Tom's idea that dew would not form because it would be too cold at the high altitude where the airplane flies and thus ice would form instead. While providing this causal explanation, Paul blended a science register and joking by performing himself as a scientist, linguistically, paraverbally (e.g., clearing his throat, laughing at the end of his statement, dramatic pauses and intonation), and nonverbally (e.g., raising eyebrows, and changing direction of his body to face other youth and Minjung). By this blending, Paul was able to communicate his ideas in a less threatening environment. By laughing at the frame Paul has set, his peers communicated their understanding of the moment and offered a supportive environment for Paul to freely share his ideas and engage in the science discourse. Furthermore, framing his discursive participation as a joke allowed Paul to enact his identity that was readily recognizable, such as a joker and/or a funny person,

Excerpt 1

((Paul and Tom are seated next to each other.))

¹1 Paul: (***) man ((Paul pats Tom's shoulder and leaves his hand there.))

2 Tom: This is my uncle Bob and brother = ((Tom places left hand on Paul's right shoulder and Paul places right hand on Tom's left shoulder.))
((All laugh.))

3 Tom: = He will now (***) this one for me. ((Tom and Paul remove their hands from one another's shoulder.))

4 Paul: Alright ((Paul places his hands on the desk and clears his throat.)) (1) ((From his "ready" position, Paul opens his body to address the group.)) Here's the Tom-Paul theory.
((All laugh. Paul looks toward Chit, who is seated by his left. Chit has her head thrown back in laughter. Nanda and Tom are laughing hard and even Bo, who is usually stoic, is smiling in the corner.))

5 Mavreen: Tom-Paul Theory? ((Utterance spoken laughingly.))

((Chit is laughing and excitedly tapping on her legs. Chit then nudges Paul.))

6 Paul: We believe (1) WE STRONGLY BELIEVE - ((in an exaggerated booming voice))

7 Chit: ((Paul's gaze is directed toward Minjung.)) Yeah, as the rest have said it, ah (.) there should be (.) it's gonna be

8 Paul: We strongly believe that it will not form a dew. (1) Ah:: (.) Because (.) ((Paul clears his throat and then laughs.))
((Nanda chuckles and Chit and Inzali smile.))

9 Paul: ((Paul's gaze is directed toward Minjung.)) Yeah, as the rest have said it, ah (.) there should be (.) it's gonna be colder (.) at the (.) outer part of the atmosphere. Because the sun (.) the heat from the sun is radiate ah (.) away from the uhm surface (.) as it goes (.) it loses the heat (.) and then since the airplane is so high out so high (.) it would (.) instead of forming a dew it will form (1) ice. (1) ((Paul raises his eyebrows))
((All laugh.))

10 Paul: And then ah:: we also believe that dew doesn't include ice in its definition (.) because dew is a liquid form of the ... ((Paul makes a semicircular motion with two fists put together.))

as indicated in the group's immediate and loud laughter and to effectively manage the scientific activity and share his ideas (participating in the science discourse) (Kamberelis & Wehunt, 2012).

Theme 2: The youth utilized place-based ethnic practices and shared knowledge when participating in science discourses

In school, students are introduced to the unique discourse patterns of science and expected to acculturate to these patterns (Lemke, 1990, as cited in Brown, 2004), in what themes are delivered and how discourse is delivered. For example, the experiences and knowledge minoritized students bring and share with classmates may be viewed as irrelevant or not interesting to students from dominant backgrounds (Duff, 2003). Students from nondominant language backgrounds tend to use "lengthy, repetitive, redundant talk that includes personal experiences and emotional reactions as well as science-related ideas" (Lee & Fradd, 1998, p. 17). As a result, minoritized students' discourse patterns may be undervalued or even perceived as disruptive, as they are incongruent with mainstream science discursive patterns (Brown, 2006). In such contexts, students' engagement with science discourse can be problematic if it asks them to give up cultural affiliation and assimilate to the dominant science classroom culture.

Youth in Project RESET negotiated new ways of participation by leveraging topics that are often in conflict with what is valued by the teacher and the institution (Brown, 2004; Lee & Fradd, 1998) and created a space in which they could talk about their personal experiences as they engaged in the science discourse. Thus, the youth collectively made it possible to talk about their Chin practices, experiences, and knowledge and challenged each other to negotiate meanings. We note that since the Project RESET curriculum focused on weather and climate change, the youth's experiences of living in Burma and the first-asylum countries prior to migration to the United States provided important resources for their engagement in the science discourse.

In the following episode from Week 1, the youth participants talked about the Burmese practice of using *thanakha* (a yellowish-white cosmetic paste made from ground bark). The discussion was prompted when youth were asked about the differences in weather in their current city and the other places where they had lived:

Excerpt 2

- 1 Minjung: Anything else that you notice that is different between living here and living in Burma?
 2 Chit: We don't put sunscreen. We put the tha[nakha = ((Chit makes circular gestures to her face.)) =
 3 Minjung: [Oh yeah.
 4 Chit: = to cool ourselves.
 5 WW: Put what?
 6 Minjung: Thanakha.
 7 Chit: It's kind of like [clay =
 8 Paul: [It's like a dirt-like
 9 Chit: = You know like
 10 Daisy: ((Whispers to Chit.)) It's not clay.
 11 Chit: It's not clay and it came from the tree and we do like this = ((Chit makes a stirring gesture.))
 12 WW: Uhuh, you mix it up?
 13 Chit: = and we put it on our face.
 14 Jaimie: It's from Thailand.
 15 Minjung: Thailand?
 16 Jaimie: Yeah.
 17 Paige: No, you don't mix it. We put water ((Paige makes a stirring motion.))
 18 WW: What color?
 19 Paige: Cream color.
 20 Byn: This color. ((Byn points to her face with her pointer finger.))
 21 WW: Same color?
 22 Byn: Skin color.
 23 Daisy: It's cream.
 24 WW: Cream.
 25 Chit: It cools us down.
 26 Jaimie: It's skin whitening and sun radiation proof.
 27 Paige: It's like that ((pointing to the wall)), that wood.
 28 Minjung: Really?
 29 Jaimie: Yeah. It's sun radiation proof. And then it's very good for your acne and stuff.
 ((All laugh.))
 30 Minjung: Oh!

In Turn 1, Minjung's question prompted Chit to say that "we" (Burmese or Chins) use thanakha instead of sunscreen. It is evident that Chit positioned Chins as distinct and different from the three facilitators, Minjung, WW, and Mavreen, who are not Chins. In this episode, the youth juxtaposed different ideas that they have developed through diverse experiences with thanakha. Disagreement seems to be expected here, evidenced by the lighthearted arguments and overriding of each others' ideas (Turns 7, 8, 10, 11). In the process of reaching a consensus, they positioned themselves as experts about this topic and tried to inform the three facilitators. In addition, animated gestures, overlapping utterances, and frequent laughter throughout this episode suggest that the youth had a lot to contribute to this discussion. Humor and laughter is likely an idiom of their mastery of knowledge that allows them to mediate the relationship between themselves and scientific adults.

Starting in Turn 14, the discussion was split into two threads and the youth held two simultaneously occurring conversations. Jaimie's statement about the benefits of thanakha in Turn 29 elicited laughter from the whole group. This indicates that despite the split in the conversation, the youth were fully engaged in most ideas being offered in both threads. This laughter also allowed the split in conversation threads to converge. This kind of discussion, in which learners engage in multiple simultaneous conversations, is not often practiced in school classrooms. Rather, a teacher implicitly or explicitly coordinates students' speech turns and only one person speaks at a given time. Unlike in school science practices, through these two parallel discussions, the youth freely added to the discussion by leveraging their heterogeneous experiences and expertise and demonstrated their excitement and engagement. In this moment, rather than privileging one experience, the youth negotiated the discursive space to allow multiple ideas and knowledge that build on an individual's unique experiences and interpretation of Chin practices. Through humor, they advanced their own modalities of knowledge that are often undervalued in many dominant school sciences. By doing so, they enacted an identity as experts of Chin culture, practices, and technology, and as individuals who are more knowledgeable than adult facilitators.

Theme 3: The youth coordinated turn-taking and responded to others' ideas in a way that makes the learning environment safe and inviting to all

In school classrooms, not all students have opportunities to participate in or contribute to the classroom academic discourse. For instance, students' social status, popularity, and racial, socioeconomic, and linguistic backgrounds influence who gets the floor and how their utterances are taken up by others (Bianchini, 1997; Kurth, Anderson, & Palincsar, 2002). These interactional dynamics further determine what and how well students learn (Goldberg, Welsh, & Enyedy, 2009). Carlone, Haun-Frank, and Webb (2011) argued that learners can be agents who make participation opportunities equitable to all when they "buy in and contribute to [the] development and maintenance" of equitable practices (p. 465). In Project RESET, youth participants cultivated various social interactional norms that shaped the learning setting to be more accessible and inviting to everyone. Specifically, they provided participation opportunities for peers who do not often get the floor and/or speak English with limited proficiency. The youth achieved this by policing those who dominated the conversation, giving reassurances and allowing wait time, and showing respect for each others' ideas by giving proper credit.

An illustrative example of this theme occurred after Paul stated that dew does not include ice in its definition in Turn 10, Excerpt 3. In Turn 1, Chit said "zag" to announce the next person to share his or her ideas. This turn-taking practice was chosen by the youth earlier to ensure that everyone shares their ideas. We recognize that such mechanical turn taking may have been learned from school science classrooms and limit learners' productive and dialogic exchange of ideas (Carlone, Huan-Frank, & Webb, 2011). We have observed instances in which the youth took their turn, shared

Excerpt 3

- 1 Chit: Zag ((Chit points toward Neo and herself. Earlier, the students decided to do "zig and zag" to determine their turn-taking order.))
- 2 Neo: Alright. ((Neo claps his palm to his fist.))
- 3 Paul: And ah ((Paul scratches his neck)) okay.
((Win Shwe raises her hand.))
- 4 Minjung: Oh you (***)
- 5 Paul: (***)
- 6 Chit: She has a question ((Chit points to Win Shwe. Minjung points to Win Shwe.))
- 7 Tom: ((Tom points to Win Shwe.)) You can ask.
- 8 Paul: Ask (***) ((Paul's gaze is on Win Shwe.))
- 9 Win Shwe: (***) Ice has to be liquid first.
- 10 Paul: Yes, it has to be liquid first (.) ((Paul makes an open palm gesture. Chit's gaze is on Win Shwe.)) But then since (.) it's so cold (.) it (.) is
- 11 Chit: No::: ((She looks at Paul on her right.)) [she is =
- 12 Paul: [It's not HOT enough to-
- 13 Chit: = She is right ((Chit wags her pointer toward Win Shwe, who is seated on her left.)) Okay (1) Water vapo:: vapor ((Chit makes a square in the air with both of her hands)) cannot turn into ice like tha:t. It has to be: in liquid form first.
- 14 Paul: No. ((Paul turns slightly toward Chit.)) I think it can ((puts his hand on his chin)) [because hail- ((makes a counting gesture with his pointer finger)
- 15 Neo: [Wha:::t? ((in a singsongy voice))
((Neo chuckles.))
- 16 Chit: Water vapor is [gas = ((She puts her thumbs and pointer finger together and she turns toward Paul.))
- 17 Paul: [No because like how ((Paul faces Minjung.))
- 18 Chit: = invisible gas
- 19 Paul: No, no, how they combine (1) ((He turns to Chit.))
- 20 Nanda: What? ((Nanda, Chit, Neo, then Tom laugh.))
- 21 Neo: What combine?
- 22 Paul: Okay. ((Paul laughs. The group laughs.)) Okay (***) alright a small particles (.) of the air (.) of the ah (***) group dense to get it to form a cloud [and then =
- 23 Chit: Dense?
- 24 Paul: = yeah (.) and then that cloud, when it's too dense it falls into water right? But then sometimes it falls as in snow, hail, which is basically ice, so
- 25 Chit: Snow and hail are liquid first ((Chit moves her cupped hand.)) [before =
- 26 Win Shwe: [Yeah in the air
- 27 Chit: = They are water.
- 28 Nanda: They're water first and then fall ((Nanda moves her middle and pointer finger in a falling motion.))
- 29 Chit: They turn into liquid first and then ((Chit moves her inverted cupped hand.))

ideas, and moved on to the next person without engaging in the ideas shared by the speaker. However, we argue that this turn-taking practice was used to ensure equitable opportunities for sharing ideas of all the learners by allotting everyone time to hold the floor. This can be particularly helpful for those whose English proficiency is low and/or who have difficulties in getting the floor. In Turn 6, Chit noticed Win Shwe's intention to present her idea whereas others did not. We note that Win Shwe had a lower English proficiency than some other youth like Chit and typically spoke in a quiet voice. While carrying out the "zig-zag" turn-taking practice, instead of adhering to the practice, Chit (and other participants) negotiated the floor in each interactional moment to ensure that everyone's, especially quiet ones', ideas were heard.

Furthermore, this episode shows how the youth participants credited each others' ideas and built on them in scientific sense making. When Win Shwe pointed out a loophole in Paul's argument, Chit explicitly called the attention of all participants to Win Shwe's idea by saying, "She is right" (Turn 13) and further elaborating on it (Turns 16, 18, 25, 27, and 29). Win Shwe agreed (Turn 26) and Nanda also supported the idea (Turn 28). Chit's follow-up encouraged Paul to articulate his idea and engaged other participants in a scientific discussion regarding phase change, how clouds form, and how precipitation occurs. Without Chit's efforts to help Win Shwe share her thoughts and coconstruct the ideas, the learners would not have entertained Win Shwe's different and scientifically sound reasoning. The youth's practices (e.g., turn taking, yielding the floor for peers who are reticent or speak English with limited proficiency, crediting and building on others' ideas) supported not only an equitable learning environment, but also everyone's science learning. In this episode, the youth, especially Chit, enacted an identity as someone who supports peers' participation and learning opportunities, cares about their ideas, and genuinely builds on them for her own and others' learning.

Discussion and implications

Our findings shed light on how resettled refugee youth crafted space for participation in a community-based STEM program. They resisted common understanding of science discourse as something not for them and employed their own humor, indigenous knowledge, and processes of collaboration to make a space for themselves within it. In particular, we showed how the youth validated their funds of knowledge from home and/or youth culture (e.g., humor) as important assets and valued themselves and others as individuals who are situated with histories and cultural experiences (Calabrese Barton & Tan, 2009). Science discourse was blended with Chin experiences and joke making while providing equitable participation opportunities for all members. Their engagement in laughter, joking, and playfulness reflects the comfort they felt in the learning environment (Aikenhead & Jegede, 1999). In this process, they enacted and blended multiple aspects of their identity in a seamless way, including humorous teen, capable science learner, Chin who is knowledgeable about Chin practices, and an individual who helps peers' ideas to be heard and valued. Through these practices, they supported and challenged themselves and each other for new learning.

The youth's practices resonate with what Upadhyay and Albrecht (2011) argued are components of a deliberative democratic classroom: (1) evidence-based argument or reason giving, (2) equity in participation and decision making, and (3) respect and value for others' knowledge. The youth participants in our program engaged in these three components and further incorporated joke making and playfulness, which may be a characteristic of youth culture. We argue that through creating and participating in these discourse practices, the youth crafted and participated in critical science literacy practices.

We draw implications from this work for global contexts of narratives that demoralize and marginalize refugees (Steimel, 2010) and what educators and researchers can learn from these youth's local practices of science discourse to disrupt a deficit perspective on marginalized youth (Taylor & Sidhu, 2012). Based on the findings, we call for implementing informal STEM enrichment

programming and research that empower refugee youth by building on the rich and diverse funds of knowledge they bring to learning settings. Resettled refugee youth, perhaps more broadly migrant youth, may develop diverse place-based knowledge that can be used in many subject areas, such as science (e.g., weather, climate, geology, natural resources) or social studies (e.g., culture, politics, history). Youth who have experienced inequity in their home countries and/or in the process of migration may bring strong dispositions to equity, at local and global levels. When encouraged and valued, these youth would contribute rich knowledge and disposition to the learning settings, which in turn leads to their own empowerment as valued members and all students' development of knowledge and disposition.

In the context of science teaching, the transformation of the notion of science learning should begin with the recognition of values that refugee youth bring and how conventional science discourse fails to recognize those values. As the students in this study intuited, it is part of the gated community of science identity that is often subtly closed off to them. If science learning is defined only as an acquisition of canonical knowledge and practices, teachers may not recognize experiences, knowledge, and dispositions that refugee youth can contribute nor the ways in which students' performance is linked to the degree to which they can identify with and become comfortable in science discourse itself. If science learning is viewed more broadly as engaging with various experiences and knowledge, collaborative sense making, and aiming for a democratic society, their resources can be more meaningfully drawn into science discourse. Additionally, science does not have to be taught as an isolated subject, but rather integrated with other subject areas, such as social studies. In such an integrated learning context, science can be framed as a human endeavor that involves culture and societal concerns and values, rather than a culture- and value-free discipline that is irrelevant to human lives.

Without the many constraints of state-mandated standards, informal learning settings may better support these research and instructional approaches. Informal education settings can move beyond providing remedial help and provide space in which youth can share their values and experiences freely, perform their various identities, and be empowered. We note that the resources our program had (e.g., stable support from a community organization, space provided by the school, governmental and/or university funding) are crucial to helping students who would otherwise be alienated from science discourse to enter the STEM arena. Moving beyond informal education settings, we call for changes in in-school education settings. In-school teaching practices should present science as well as other subjects to be more relevant to individuals' experiences, and various youth practices and culture such as playfulness and laughter. Furthermore, this presents science as open to all learners rather than only those who are positioned as competitive students. Teachers should also focus on inviting students into the discourse of science by acknowledging the implicit and explicit assumptions and biases in the way science is perceived, projected, and embedded in broader societal discourses. In this environment, use of diverse learners' funds of knowledge can be maximized for all learners' learning.

Note

Transcription conventions are adapted from the Jeffersonian Transcription Notation (Jefferson, 1984).

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Symbol	Use
[text	Indicates the start point of overlapping speech
=	Indicates the break and subsequent continuation of a single interrupted utterance
(# of seconds)	A number in parentheses indicates the time, in seconds, of a pause in speech
(.)	A brief pause, usually less than 0.2 seconds
•	Indicates an abrupt halt or interruption in utterance
ALL CAPS	Indicates shouted or increased volume speech
underline	Indicates the speaker is emphasizing or stressing the speech
:::	Indicates prolongation of an utterance
(***)	Speech which is unclear or in doubt in the transcript
((text))	Annotation of non-verbals and contextualization commentary

All youth are referred to by pseudonyms and facilitators are referred to by initials.

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Resettled Refugee Youths' Stories of Migration, Schooling, and Future: Challenging Dominant Narratives About Refugees

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Abstract In the United States and around the world, refugees are frequently portrayed as helpless victims, burdens of the host society, and potential criminals. Similarly, in schools even well-intentioned educators focus on what they lack, rather than the various stories, experiences, and perspectives they have to offer. To provide another perspective, we aim to find ways to empower resettled refugee youth and draw implications for education of former refugees and other marginalized students. Through interviews, we sought to understand the stories of ten former Burmese refugee adolescents with respect to their backgrounds, migration, and school experiences. Our analysis shows that they recognized their marginalized positionings in the United States that are attributable to their limited English proficiency, ethnicity and race, and former refugee status. They, however, authored narratives of themselves that contest such marginalizing narratives by providing diverse stories of refugees different from dominant ones and positioning themselves as valuable members of local communities and change agents for a more equitable society. These findings call for pedagogical approaches in which schools and communities provide space for stories that former refugee youths bring, value stories authored by them, and draw on their perspectives on inequity and social transformation.

Keywords Refugee education · Counternarratives · Burmese · Empowerment of youth

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Introduction

According to the United Nations High Commissioner for Refugees' (UNHCR) report in 2015, more than half of refugees around the world are school-aged children and adolescents (UNHCR 2015). These resettled refugee youths bring a unique set of challenges to classrooms in the host country. Research studies and reports indicate that many former refugee youths have experienced trauma in their home countries and in the process of migration, had interrupted or no formal schooling, or have not developed proficiency in English (Matthews 2008; McBrien 2005). Upon entering schools, these students are often positioned as racial minorities and learners with limited language proficiency and literacy (Ramirez and Matthews 2008). Refugee youths' pre- and post-resettlement experiences like these may prompt them to develop a set of perspectives about schooling and learning that are different from other groups of racial minority and English learners. A nuanced understanding about their life contexts is key to recognizing and responding to the unique and complex needs of resettled refugee youth (DeCapua and Marshall 2010; Mendenhall et al. 2017; Taylor 2008).

In this study, we seek to provide an understanding about resettled refugee youths by examining stories that ten Chin¹ high school adolescents construct about their experiences as refugees, Chin youths, and learners in the United States. We are particularly concerned about dominant narratives about refugees and educational practices that are deficit-oriented and disempowering. Our study documents how the refugee high school adolescents were marginalized in U.S. schools, on the one hand, and how they made sense of their experiences and agentively authored their identities in more empowering ways within the contexts, on the other. Based on the findings, we suggest implications for the education of resettled refugee youths and learning environments that go beyond the deficit perspective and encourage youths to challenge dominant narratives and construct more empowering narratives for and about themselves.

Literature Review

Dominant Narratives About Refugees

Refugees are often described as tragic victims, nuisances, or potential invaders and criminals in host countries across the world (Baker and McEnery 2005) and in the United States (Steimel 2010). The media contribute to such narratives by characterizing refugees as helpless victims situated in life-threatening conditions (e.g., wars, political and religious persecution, and hunger) in the country of origin. For instance, news articles frequently use phrases implying hardship (e.g., "plight of,"

¹ Chin is one of the major ethnic nationalities in Burma/Myanmar. They live mostly in the Chin State, Burma/Myanmar but are also found in the Mizoram State, Bangladesh's Chittagong Hills Tract, and India (Center for Applied Linguistics 2007).

“despair of,” and “tragedy of,” p.206, *ibid*) in describing asylum seekers in combination with harrowing images. The media also portray refugees as burdens of the host country that provides financial support and other legal services for them (UN General Assembly 1981). This narrative is represented in texts that describe refugees with respect to their numbers, such as “tens of thousands” and “more and more” (Baker and McEnery 2005), which implies that the number is troublesome. Refugees are even likened to natural disasters (e.g., “the flood of refugees” or “pests”) and “threats to the capitalist way of life” (p. 209, *ibid*). Furthermore, frequently used phrases like “genuine refugees” or “real refugees” in news articles suggest how the host society questions the authenticity of their refugee status and whether they have committed crimes and have the potential to commit crimes, such as terrorism, violent protests, and other kinds (Loring 2016).

These characterizations of refugees in the media are also reflected in legal documents. To be qualified as a refugee and admitted to another country, asylum seekers must prove life conditions that threaten their lives in the country of origin and provide rationale for resettlement (e.g., “burden of proof,” “necessity of evidence,” and “documentation” in the U.S. Immigration and Nationality Act, p. 31, Loring 2016). Once resettled in the host country, they must attain “economic self-sufficiency” within a certain period of time after their resettlement² (p. 23, Loring, *ibid*). Voluntary agencies consume these narratives about refugees and simultaneously contribute to the reproduction of them by choosing to use tragic images and stories to solicit financial support. While with good intentions, these practices inadvertently perpetuate the idea that refugees are helpless victims who need extra help (Sampson 2016; Tyeklar 2016). Despite its efforts to avoid this depiction, UNHCR also characterizes refugees as victims by highlighting problems they encounter and their needs, and by calling for help (Baker and McEnery 2005).

Educational Practices for Former Refugee Students

Hattam and Every (2010) argued that school contexts are influenced by the larger societal contexts in general and how refugees are perceived in the society in particular. As expected, we recognize a certain degree of parallelism between dominant narratives about refugees and educational practices for former refugee youths. In education research, many studies are focused on their limited English proficiency, interrupted formal education experiences, and limited literacy in their first language (e.g., Miller 2009; Olliff and Couch 2005). These studies suggest providing intensive English training or explicit teaching of content-specific vocabulary to facilitate content understanding. Other studies address coping with traumatic memories and aim to facilitate refugee youths’ acculturation and adaptation in the new destination society (e.g., Taylor and Sidhu 2012). Thus, psychological interventions are suggested, such as targeted counselling to help the youths overcome their mental trauma and live mentally healthier lives.

² Currently, this period is eight months in the United States (Halpern 2008).

While we believe that offering support for linguistic, mental, and emotional needs of resettled refugee youths is important, these approaches are not sufficient. First, the tendency to overemphasize trauma, hardship, and despair in discourses about refugees may lead to internalization of the dominant narratives that disempower the youth as victims lacking agency and control (Ludwig 2016). As Matthews (2008) argued, it is not known how refugee youths respond to traumatic experiences and how resilient and resourceful refugee youths may be in coping with trauma. Second, those approaches may overshadow the individual experiences and other aspects of refugee identity and history (Marlowe 2010) and mask the post-migration experiences, such as poverty, prejudice and discrimination, and uncertain immigration status (Matthews 2008; Taylor and Sidhu 2012). Refugee youths may experience challenges in social interactions, negotiating their identities, and learning and participating in school that are largely attributable to the very dominant narratives that portray them (Hattam and Every 2010; Keddle 2012).

We recognize a dilemma as to how to identify and accommodate their needs while not subscribing to sweeping narratives about helpless refugees in need of support and disempowering them (Shapiro 2016). Teachers and researchers alike seem to be inadequately prepared to identify and respond to refugee students' needs *and* strengths, but rather rely on dominant narratives that oversimplify who resettled refugees are (Roxas 2010). A mere emphasis on their needs and challenges may reinforce deficit perspective of students who are different from those in dominant groups (Uptin et al. 2013; Keddle 2012). An urgent need exists to overcome this deficit perspective and find ways to empower these youths (Matthews 2008).

Refugees' Construction of Narratives

In this study, we seek to find ways to empower the resettled youths by soliciting and representing stories authored by the youths themselves. Storytelling is an essential form of social interactions and serves as a critical locus of identity work (Schiffrin and De Fina 2010). While telling stories, narrators position themselves vis-à-vis stories told in the moment, the interactional situation, and dominant narratives circulating in the society (Bamberg 2004). In this way, they explicitly and tacitly construct what kinds of person they are. This discursive construction of self and identity is partly located within and shaped by the social and cultural world the story is referring to and partly contingent upon various aspects of the interactional setting (De Fina 2000; Harré 2010; Schiffrin 1996). Thus, one's stories about themselves are not carried over stably and coherently across interactional contexts and moments, but constructed dialogically and dynamically and improvised in the moment of interaction. In these locally constructed stories, narrators negotiate multiple outside forces that pull themselves in different directions and author stories that are sometimes aligned with the dominant narratives and at other times challenge them (Bakhtin 1981; Bamberg and Georgakopoulou 2008).

Several studies have examined stories that refugees generated and contested dominant narratives about refugees. For instance, Marlowe (2010) demonstrated that Sudanese refugees were concerned about the victimhood narrative and

challenged being characterized as “traumatized” for better employability in the host society. In a study about Palestinian refugees in Jenin Camp after the massive Israeli invasion in 2002, Tabar (2007) showed how the survivors’ stories provided local narratives and challenged a singular categorization as victim or hero. These local stories, Tabar argued, became a center of resistance and space to envision a hope for the future. Furthermore, Lenette et al. (2015) employed digital storytelling as a tool for producing counter-narratives in their social work with women of African refugee backgrounds. Former refugee women in this study created their stories focusing on achievement, future aspiration, and resilience within challenging life contexts. These studies, conducted in different contexts for various purposes, shed light on the lived experiences of the refugees, their agency in authoring their own identities and stories, and complexities in their experiences. By doing so, they also provided multiple and heterogeneous stories of refugees localized in unique contexts that confront “the danger of a single story” (Adichie 2009).

Some scholars specifically focus on former refugee youths and examine youths’ narratives about their experiences and identities. Mosselson’s (2006) interviews of resettled female refugee adolescents from Bosnia showed that in U.S. schools the youths experienced being treated as “exotic” and “foreign” individuals who “had seen the worst of life” (p. 26). To cope with the challenge, some adolescents studied hard to excel academically and comply with American education, culture, and values. Similarly, Uptin et al. (2013) showed stories constructed by former refugee youths in an interview setting regarding how they are marginalized and “othered” in schools because of their racial and linguistic backgrounds. Unlike the participants in Mosselson’s study, some participants in this study spoke up about structural inequality or openly shared their past experiences when opportunities were given. In this way, they “refused being positioned in ways that will adversely affect their education” (p. 133). In a study utilizing visual arts, Ramirez and Matthews (2008) demonstrated that the youths turned narratives of risk into protection, pursued fun and peace, and shared hopes for the future, rather than foregrounding negative experiences. Similarly, Cassity and Gow (2005) engaged African refugees in art-based activities, in which the youths constructed various stories that revealed tensions between past and future, trauma and hopes, and places of origin and resettlement.

We situate our work in this line of research. Our goals in this study are to examine narratives about resettled refugees authored by the youths themselves and suggest ways to capitalize on their diverse stories and agency to construct such stories that challenge dominant narratives. To this end, we interviewed ten resettled refugee adolescents in Midwest City in the United States who were born in and had left the Chin State in Burma/Myanmar. Our analysis shows that they recognized marginalized positions imposed on them in the United States because of their limited English proficiency, ethnicity and race, and former refugee status. They, however, authored narratives of themselves that contest such marginalizing narratives by providing multiple stories of refugees and Chins different from dominant ones, and positioning themselves as valuable members of local communities and change agents for a more equitable society.

Table 1 Summary of the participants

Name	Gender	School grade at time of interview	Age at displacement ^a	Languages ^b
Daisy	Female	10th	6–7	Matu, English, Hakha, Burmese
Bailey	Female	12th	9	Hakha, English
Dorothy	Female	12th	15–16	Falam, English, Hakha, Burmese
Tait	Female	11th	7–8	Zophei, English
Valerie	Female	11th	9	Burmese, English
Tom	Male	12th	10	Zophei, English, Hakha, Burmese
Neo	Male	11th	8	Hakha, English
Yoongi	Female	11th	8–9	Zophei, English, Laiholh, Burmese
Jamie	Female	11th	4–5	English, Zophei, Hakha, Mizo
Paige	Female	10th	5–6	Burmese, English, Mara

^aSome participants reported their age of displacement while others did not. When we did not know the exact age of their displacement, we estimated based on interview content

^bThe Chin speak 20–25 languages that can be categorized into four groups based on linguistic similarity: Northern Chin (Tedim, Sizang, Kuki), Central Chin (Hakha, Falam, Mizo), Southern and Plains Chin (Matupi, Mindat Cho, Khumi, Aso), and Maraic Chin (Senthang, Zophei, Zotung) (Center for Applied Linguistics 2007). In listing languages that participants speak, we listed them in the order of the language they felt most comfortable speaking to the least comfortable speaking

Methods

This study was situated in a community-based after school and summer program that targeted former refugee Burmese high school youths, offered by a non-profit Burmese organization, *Burmese Center*, in Midwest City.³ Midwest City is a popular destination of resettled Burmese refugees and is home to more than 14,000 Burmese. The Burmese Center was located in a neighborhood highly populated by resettled Burmese refugees, primarily Chins.

We conducted semi-structured interviews of ten Chin high school teens who participated in the after school and summer program (Table 1). All youths interviewed attended one of the two public high schools in the neighborhood in which Burmese Center is located. Both high schools enrolled approximately 2200 students, and 17% of the student body were Asians. While the exact number of Chin student enrollment was not acquired, the two schools were known for enrolling a large number of Chin students. As indicated in Table 1, the ten participants were multilingual, with varying levels of proficiency in the second and third languages that they speak. All but one (Dorothy) had very little English language study prior to coming to the United States. Most participants moved to their first asylum country (mostly Malaysia), lived there from a few months to three years, and were then relocated to the United States. Their length of living in the United States ranged from 2.5 to 11 years at the time of the interview.

³ All names are pseudonyms.

Each interview lasted approximately one hour. We started interviews with questions like, “Tell me about how you came to live in the area,” “Tell me about yourself in school,” and “How did you join Burmese Center activities?” We further asked sub-questions and probing questions. Our approach to interviews was ethnomethodological in that we view interviews as a performative and interactional activity (Baker 2002; Schiffrin 1996; Smith and Sparkes 2008). We view an interview as a social interaction organized by a particular set of norms that allows both interlocutors to discursively construct their identities. As De Fina and King (2011) argued, we believe that interviews allow ordinary people to construct narratives drawing upon their lived experiences, while distanced from direct interactions with other social actors, and thus are “a privileged site for the negotiation of social reality” (p. 166). Thus, our goal is to identify what stories they choose to tell us and what identities they discursively construct while complying to and resisting dominant narratives. In this regard, we were interested in “accounts” rather than “reports” of their migration and identities (Baker, *ibid*).

All interviews were audio-recorded and transcribed verbatim. In analyzing the data, we identified *themes*, intransitive outcomes of our sense-making of the data (van Manen 1990). To maximize insights that each of us brought to the data analysis, the two authors first reviewed interview transcripts and generated themes individually. We then met and discussed the themes and revised these initial themes (e.g., “language challenges,” “career aspiration,” and “reasons of migration”). We compared the themes to identify what was repeating, related, or conflicting, and generated upper-level themes that are more theoretically laden than the initial themes (e.g., challenging popular narratives about refugees). Based on the analysis, we reconstructed the participants’ stories around identified common themes while also paying attention to differences and conflicts. We believe that their stories may be shared by other resettled Chin refugees, or refugees of other ethnic groups, in similar versions.

Findings

The youths we interviewed formerly resided in small villages in the Chin State in which they experienced economic hardship, limited medical care, and oppressive military rule. To avoid threats from the military regime and seek better living conditions and education, fathers of some participants had left their families and been separated from the other family members for several years before they reunited in the United States. Some participants vividly described challenges in the migration process, such as staying in a jungle for days, walking long distances on dark nights, and hiding valuable belongings in their mother’s hair bun. They talked about difficulties in adjusting to living in the United States in the early days after resettlement. They talked about both challenges and strategies to navigate their school’s academic and social spheres. Here, we show ten youths’ stories of living in the United States and going to U.S. schools. We organize their stories with respect to how the youths became part of the existing racial and linguistic order in the United States and how they challenged dominant narratives about them and celebrated who they are.

Becoming Part of the Existing Racial and Linguistic Order

From their first day in the United States, the youths were subject to positioning as racial, linguistic, and socioeconomic minorities, which were manifested in several different ways. We recognized the participants' experiences of their lower social positionings and entering into the existing social order in their stories about how they were living in marginalized neighborhoods, marginalized in school, and subscribing to mainstream ideologies.

Living in Marginalized Neighborhoods

Most youths vividly remembered the early days after they landed in the United States. Those memories appeared to be full of varied, and sometimes conflicting, emotions, such as excitement, worry, hope, and disappointment. One emotion that drew our attention was their disappointment in the place they were relocated. The youths expected to live in well-developed cities, often portrayed as having tall and modernized buildings, in which middle class citizens resided. They had seen cities with glamorous skyscrapers in movies or while living in big cities in Malaysia. Tom said that he could see the KLCC, the tallest building in Malaysia, and loved the “crowd and the buildings and cities.” Tom and other students probably hoped to live in a big city and enjoy a middle-class lifestyle in a developed country. Yet, that was not what was waiting for them:

Neo: I thought we were gonna be in like, metropolis, like where it's really urbanized, but they drop us off at kind of like a ghetto place

Several other participants similarly mentioned their disappointment at not being able to see tall buildings. Perhaps, this might have been their first experience of being positioned in a lower social rank in the United States.

Marginalized in School

Similar to memories of the early days after resettlement, the participants described experiences in a new school in the United States with both worry and excitement, as Bailey said, “It was fun and scary.” They were scared because they did not speak English or know about school routines. Valerie said because she could not speak English, she “was very quiet and that was about it.” Even foods were new. They shared these experiences in a calm tone of voice or sometimes with laughter.

From the early days in this new country, the youths recognized English as a critical asset for succeeding in school and upward social mobility and were determined to master English as fast as they could. To learn English, they read books and tried to find as many opportunities as possible to talk in English. Despite such efforts to learn English, acculturate, and succeed in U.S. schools, students

have experienced subordination and marginalization because of their race, ethnicity, and language. The most salient experiences of marginalization were bullying and teasing of peers:

- Valerie: It was elementary school, so of course there was some mean people. The worst part was I didn't know what they were saying, but I could tell it wasn't something good
- Daisy: Sometimes it's sad because they would like tease me wrong, saying, "You don't really know the language" like, "You come here because you want, like money or something because your country's poor." It is true, but sometimes when they say [that, I] kind of feel sad

Not just peers, but sometimes teachers also were not supportive of the youths. Neo wanted to connect with teachers, but it was not easy because some teachers were "not that open about it" and "a little bit uncomfortable" with him. Tait talked about a "racist" teacher in her school who did not explain to her about the class content and let her learn on her own:

- Tait: ... then whenever like White people go up to her, she's like really nice, all happy, smiling, and then she kind of gives them her attention, but whenever I ask her, I feel like she doesn't really want to answer my questions, so I stop asking her questions

It appeared that they had developed close friendships mostly with other Chins because of the ostracism and marginalization they experienced.

When asked to describe themselves in school, the youths said they did not talk much in school or ask questions to teachers. Dorothy said, "I don't know why, but I hardly ask questions. I'm afraid to ask them during the class." She added that all Chin students, not just herself, do not like to ask questions, whereas American students "just raise their hand every time and ask questions." When asked to think of reasons for it, she explained that they lived "under military control for so many years" so are "afraid" of asking questions. Daisy, however, provided another perspective:

- Daisy: I would feel like if I ask question, people might think like all my friend got it but I don't, I'm the only one that don't got it so like they might think like I'm dumb or something. Like I don't want to be judged in that way. They always would say feel free to ask question and stuff, but I don't really ask question

Her worry of embarrassment might be what many teenage girls experience regardless of their racial and linguistic backgrounds. However, this worry of Chin youths may be attributable to their measured or perceived English proficiency and prejudice against non-native English speakers (Ryu 2013). A candid remark from Yoongi supports this interpretation:

Yoongi: In our classes in school there's people that's smarter, that we think are smarter, you know. "Oh, they speak English so, they might be really smart." Since, like, they speak English they should, like, know a lot of stuff. So that's why we were, like, afraid to say something. It's like they might, they should have more knowledge

Yoongi was worried about peers and teachers underestimating her intellectual capability and knowledge because of her English proficiency. Later, she added that although she knew that English proficiency does not mean having more knowledge, she could "not help thinking that."

Subscribing to Mainstream Ideologies

We note that the youths appeared to learn and subscribe to several mainstream ideologies regarding language learning and acculturation of immigrants and refugees. For instance, several participants thought that they learn English best when there are less people who speak the same first language. Jamie explained, "growing up I learned that it's better to spend most of your time with English, because it helps you speak more English than hang out with Burmese or Chin." Bailey made a similar point more explicitly:

Bailey: It's [the fact that there are many Chins in Midwest City] good that we are here, but then it's not good because it's harder for American person to teach us their way of living when there is more people, because everyone learns better one-to-one or two-to-one

Assumptions that the youths showed in these quotes are, to a certain extent, similar to assimilation ideologies that many people hold and employ in judging newcomers to the country (Alba and Nee 1997). In addition, it is assumed that newcomers make an effort to mingle with "Americans" and native English speakers and to acculturate. For example, Tom said:

Tom: I have hard time making friends with American people. I don't really participate in the school activities. I don't even play sports in school. I basically cut off my tie. I went to class but I don't join any club or any other thing

Tom believed that *he* is the one who failed to make enough efforts to build social networks with Americans and cut the ties, rather than Americans or school practices being responsible for it.

Furthermore, the youths positioned themselves and others according to existing racial ideologies, which contributed to maintaining the existing system and social structure to a certain extent. For instance, in the interviews, several students constructed American-ness as "White." As an example, Valerie described student demographics in her school as "Americans, Africans, and Hispanics." Her list implies that White Americans do not need any racial qualifier while others (African and

Hispanic) require one. Tom, while explaining the schooling in Malaysia, said, “On Tuesday we’ll have an American, what I mean American is a White one, a White person. She’s from Italy.” In addition, some participants also accepted the prevalent images of Asians. When talking about her first year in a U.S. elementary school, Valerie shared a story of her receiving awards:

Valerie: I received all the gold stars that I could receive. I feel like I was more obedient than most of the students, I think that’s why. Because back in my 5th grade, my class, they were rude, and I was kind of shocked how they were so rude to adults and teachers like that. Because back in Burma, we don’t even dare to speak up to the teachers sometimes

To Valerie, not being rude and following teachers’ rules may be a way of navigating the new school system and achieving success. At the same time, her behavior may contribute to maintaining a stereotype that Asians are “submissive” and “obedient” (Kim and Yeh 2002).

Challenging Macro-Narratives

While subscribing to mainstream ideologies about language and race, the participants’ stories show how tacitly and explicitly they resist the constraints and macro-level narratives. They did so by authoring refugee narratives, authoring Chin narratives, and envisioning their future as change agents.

Authoring Refugee Narratives

Earlier in this paper, we showed how media and policy documents portray refugees with disempowering narratives, such as victims, nuisances, or potential criminals. In our interviews, however, the youths recalibrated their refugee identity as a voluntary immigrant (Ogbu 1987) and having had joyful experiences in the Chin State and migration process. For instance, Dorothy talked about how her family chose to migrate because her family wanted to reunite with her father who had lived in the United States alone, and this decision was made for herself and her siblings. Prior to migration, her family sent Dorothy to an English school in India to prepare for their impending migration to the United States. Valerie explained her migration experience as, “It was normal for me... Everything was comfortable... It was fun.” Dorothy and Valerie challenged the dominant narrative of suffering refugees who are forced to move by describing the migratory experience as mindful, prepared, and joyful, which may imply less stigma.

Another way to turn the disempowering narrative to a more empowering one was to position themselves as individuals who have valuable knowledge and experiences to share with peers and the public who do not have similar experiences and do not know about other parts of the world. As an active member of the student council, Daisy tried to raise her peers’ awareness of the refugee situation, clarify incorrect knowledge about it, and encourage them to help refugees:

Daisy: Since I'm the only Burmese in the student council, I talk about the experience and why we came here and how it's challenging, and how they can help instead of teasing

Similarly, Bailey regarded her refugee experiences as a source of knowledge and empowerment. Her migration provided her with experiences and stories that American friends do not have and "love to hear about." These stories included how they went from Burma to Malaysia, how they grew vegetables in their garden, and why there were not many people who are obese or overweight where she came from. She seemed to author herself as a broker between multiple cultural groups, who is well-versed with different cultural practices and knows strengths of each culture, and a victor who has overcome hardships of being a refugee and newcomer to the United States.

Tom contested the deficit ideas about refugees as English learners and positioned himself as an avid writer who has important ideas to write about:

Tom: I love the writing ((laugh)). First of all, my grammar is never good and I never intend to ((inaudible)) fix that. Even now I don't care about grammar, but I care more about what I am writing about and what idea I put it in my writing, that's all. I love the writing. There is a lot of stuff to write about

Tom's insistence of "not caring about grammar" is his way of positioning himself as an empowered individual who has important thoughts and knowledge to write despite limited English proficiency. This challenges the prevalent notion that equates English proficiency with a native-like fluency and style, such as accent, grammar, and vocabulary (e.g., Butler 2004). In saying this, Tom appeared to challenge common school practices that foreground English grammar and what English learners lack, and fail to consider ideas they want to express (e.g., Lee et al. 2013). As shown in these examples, the youths authored themselves as owners and providers of valuable knowledge assets, who not only gain knowledge needed in their school and society but also contribute to the collective knowledge.

Finally, we observed that the youths talked about their migration as emancipation from various kinds of oppressions, a path they and their family had chosen. To the participants, oppressions seemed to mean not only wars and persecution but also conditions that did not foster opportunities. Daisy viewed that living in the United States benefits her because "the freedom is better [in the United States]." For the youth participants, freedom indicates liberation from military ruling, an increase in educational and future opportunities, and decreased poverty, which are attributable to structural inequity. Tait said that while most of her friends in Burma can only pursue marriage, she can pursue education to attain a degree and eventually a career. Tait perceived herself as freed from the traditional gender role expected for girls—getting married at an early age and having children. Similarly, Tom would have thought of only "becoming army or a bus driver" for his future in the Chin State. After moving here, he has "many choices other than being army or a bus driver or everything." He wanted to study history, political science, and architecture, and hoped to have a career in law. He excitedly shared names of colleges he wanted to

attend and concluded, “I want to be one of the Supreme Court Judge. I guess that’s what I want to be.” In this moment in the interview, Tom narrated himself as an empowered individual who is emancipated from limited possibilities and can envision a bright future.

Authoring Chin Narratives

Most youths had experiences of living in a community with relatives and/or other Chins in their first asylum country. In this community, they met people from other sub-ethnic groups and villages than their own, learned to communicate and work together, and helped out each other. In Midwest City, they maintained strong ties with Chins through various community and church activities. Through this experience, the youths appeared to develop a strong sense of community and belongingness both within and across sub-ethnic group borders and to seek a higher status for Chin ethnicity in the United States.

One way to construct favored Chin narratives was to characterize Chins as hard-working, education-focused, and smart. The participants said, “Teachers actually love us because they see that we try hard in school” (Bailey), “Since there are more Chin people [in Midwest City], it’s more competitive, I think it motivates me to work harder” (Neo), and “A lot of Chin people talk about education in general instead of other things like the parties” (Tait). Daisy’s remark shows that this narrative builds on the model minority stereotype for Asians:

Daisy: Like, you’re Asian, you’re really smart. They [peers] would say that. Some people they would want to get close to you because they think you’re really, really smart, and then you can get more friend with it. And like, when you don’t know them, they could also help you. ... but then actually we’re on the same level, so they would still tease me right now, “You’re Asian but you’re not that smart.” ((Laughs)) We would still tease around like that but I get more friend with it

As shown through her laughter, Daisy did not believe that all Asians are smart, yet she noticed that the stereotype could be useful in social networking and utilized it.

The participants further added details to the hard-working Chin narrative by accounting for why Chin students focus on education and study harder compared to American students. The participants said:

Tait: I think our parents are there to support us mentally, but not there to support us financially when going to college. That’s why I think we all try hard in high school and then focus on education... American people have their parents to support them financially

Tom: For the American people [receiving formal education is] normal for them, I mean like that is everyday life for them... But when we come here, for the Burmese our world becomes bigger... Then we kinda have ambitions and

kinda have goal and we begin to do that... This is the advantage we have over them [Americans]

As these interview quotes demonstrate, the youths attributed Chins' strong commitment to school work to their limited resources. Their limited resources are not perceived as a disadvantage, but rather it contributes to their motivation and determination. Unlike "Americans" who own various resources for success and take for granted what they are given, Chins "learned to appreciate" daily life, including freedom from persecution, resources, and education.

Furthermore, the participants celebrated their multilingual fluency. As shown in Table 1, the participants spoke two or more languages with varying degrees of proficiency. They switched fluidly between and mixed different languages to communicate with diverse people in different contexts. What we would like to show here is not simply their multilingual proficiency, but how the youths agentively made choices as to which language to speak, were proud of their multilingualism, and recognized the value of it. They made their choice of language by the different utilities of each language (e.g., "There are phrases that are better said in English than in our language. ...When we encounter those moments, we would just use English," said Valerie) or by preference (e.g., "My brother really likes English," said Neo, and "I love Hakha. I go with what I love most," said Tom). Bailey celebrated bilingualism as follows:

Bailey: It's all cool to speak two languages, Chin and English. And like you can show off. It's really nice to speak two language. You feel special because you are here and you are on the same level as American kids, but you speak two language, they don't. I'm not saying they are dumb. It's just, it's just cool

Some participants articulated pragmatic benefits of speaking multiple languages such as the ability to cross social and cultural boundaries (Machado-Casas 2009). Neo's dad learned and spoke multiple Chin languages, which meant wider opportunities for him as a religious leader. Daisy and Dorothy could help communication between people who did not speak the same language, for instance communication between their parents and younger siblings. The youths celebrated Chins' multilingualism and tried to utilize it to benefit themselves and their community. By doing so, they also contested the deficit notion of English learners.

Envisioning Their Future as a Change Agent

When asked about their ambitions, most youths expressed an interest in the medical professions. Perhaps, they wanted to pursue a medical career as many teenagers would because of its lucrative job prospects and upward social mobility. However, we noticed that the youths commonly talked about their experiences in the Chin State, where they lacked necessary resources and medicine, when explaining why they wanted to become doctors. Because Chins "don't have the money to

go” to a doctor and doctors “don’t have the right tool and the right equipment... and much knowledge about it,” even a toothache can kill people (Daisy). Within Chin, one’s financial stability could determine their fate: “If they are poor, they would rather die because they are sick but they couldn’t find medicine” (Paige). Tait even had a harrowing experience of witnessing a patient of a gunshot wound who had died:

Tait: And this dude, he got shot and there was one doctor, I don’t even know if she was a doctor, but she took out that bullet by himself (sic) and it got infected and stuff, and then he died. So I was like, it’s a death that can be prevented. Girls that get sick and it’s just like a common flu, and then it’s not taken care of well. They’re not getting the medicine they need. It’ll get worse and they die, and it’s a death that can be prevented just by small medicine, small pill

Through their experiences of living in the Chin State and the United States, youths noticed the discrepancy in medical resources, knowledge, and infrastructure between their villages and bigger cities in Burma/Myanmar or the United States. Because of these and similar experiences, Daisy, Tait, and Paige wanted to become doctors and go back to the Chin State to help people in their villages.

Furthermore, Neo demonstrated a keen awareness of inequity within Burma in saying, “It’s [Burma] really like, I would say, segregated. Some parts are wealthy, some parts are really poor.” His, and other participants’, recognition of this discrepancy went beyond disadvantages that Chins suffer. Recognizing such inequity and injustice existing in the world, they envisioned themselves to be helping others who are suffering from inequity and injustice. For example, Jamie wanted to become a lawyer, to “help them [immigrants and refugees] with it [her law knowledge] so that they won’t get into trouble.” Valerie wanted to start a non-profit organization that helps people, in particular young children, around the world. For Neo, coming to America had helped him find his purpose, and he “turned the purpose into the good of the people,” hoping to come to the aid of people who need help anywhere in the world. The youths foresaw themselves as people who care about inequity and pursue social transformation.

We note how the youths’ awareness of inequity and desire to make changes shaped their present schooling practices. Neo, while not liking social studies classes because they taught only “what happened in the U.S.” and thus were not important to him, started liking them because the courses taught him about different parts of the world and which countries are rich and poor. Such knowledge was important for him because it would be useful in “helping other people.” He tried to catch up on world news to learn more about “how some places are being oppressed.” As noted earlier, Daisy joined the student council, shared her own story, learned about other racial and linguistic minority students, “like African or other languages,” and discussed how to “stop bullying” in school. In these moments in the interviews, we saw possibilities of the emergence of new local practices and narratives that permeate across racial and linguistic boundaries and challenge dominant narratives about race, language, and legitimacy.

Discussion and Implications

Our findings demonstrated complexities in stories about their migration and post-resettlement lives. As alluded to in the findings, the participants' stories were rife with ambivalence, tensions, and even contradictions. These were sometimes expressed explicitly (e.g., "it was fun and scary") and manifested in paralinguistic remarks that do not match with the content of their utterance (e.g., laughing while talking about hardships). In other cases, we noticed inconsistencies when they talked about school experiences. For instance, Valerie said "I wasn't shy about speaking even if my sentence were awkward and un-understandable," but, in another part of the interview, she also said "I feel like I was very quiet and that was about it." Tom, while describing himself as "I love making friends," reported "I have hard time making friends with American people." Tom even recognized the inconsistency when saying, "I'm kinda very social. I consider myself to be very talkative and sociable but I never joined school activity or club so. That's, I never understand why, even myself." Similarly, Yoongi said, "That's [that English speakers are smarter] wrong too. That's just what we think. We can't help thinking that. But that's wrong."

These inconsistencies demonstrate the tensions and ambivalence that the youths have experienced between who they want to be (e.g., someone who socializes with a broader group of peers) and who they are (e.g., someone who does not socialize with others) and/or between what they are expected to do (e.g., to not shy away and be courageous) and what resources were unavailable for them to fulfill those expectations (e.g., limited English proficiency). These contradictions shown in the interviews are not simply their own, but reflecting the contexts in which they are situated, that are filled with conflicts and contradictions of expectations and constraints. The youths navigated and negotiated this space, by conforming to the existing values and ideologies, questioning them, and making compromises. That is, they were not only victims of oppression, but also active pursuers of better life conditions, freedom, and education, and not only subordinated to the existing social structure, but also challenged it by authoring their own stories. As Bamberg (2004) expressed it, the participants were complicit with the dominant narratives and rupture them in their local contexts.

The complexity was also evident in how they utilized the model minority stereotype to position the Chin as a hard-working and academically successful group. The model minority stereotype is over-generalizing and can damage some Asians (Lee 2009). The Chin youths might contribute to perpetuating the Asian model minority stereotype by characterizing themselves as a model minority and entertaining this notion (e.g., Hartlep and Porfilio 2015). We, however, argue that accounts for how individuals engage with the stereotype is more complex than suffering from or entertaining it. We view the stereotype as a boundary object (Star and Griesemer 1989) that enters multiple local settings and is utilized differently in each setting. In our interviews, the youths tweaked, in a variety of ways, the ways in which the stereotype operates. Since the Asian model minority is often associated with East Asian and Indian Americans, the Chin youths

expanded its notion by including Chin in it. In addition, they repurposed the notion that Asians are smart and used it for instigating a conversation with non-Chin peers and befriending them. The youths purposefully employed the stereotype to make playful banters among peers, which appeared to be important in establishing social networks among adolescents. Thus, while the youths might contribute to perpetuation of the stereotype, they also expanded and appropriated social meanings of it to navigate life contexts that were limiting their possibilities in the U.S.

Based on the findings, we suggest several implications for education of former (Burmese) refugee youths, focusing on how to empower them and draw on their strengths. First, the youths felt empowered when they shared their experiences in the Chin State and their migration processes and especially when peers valued their experiences. We note that while the youths in our interviews were all Chins, they did not have the same experiences. They came from different Chin sub-ethnic groups, and their paths of migration were different. These stories of experiences can be about challenges before or during migration, cultural practices of their ethnic groups that they value, or experiences after resettlement. Youths may be empowered by sharing with and making important contributions to the class. Other students can learn from these diverse stories, and teachers or other adult educators can position themselves as genuine learners of youths' knowledge.

Second, we concur with Machado-Casas' (2009) recommendation that we should rethink deficit views of multilingual learners. In particular, we argue that these youths' multilingualism should be validated in schools. At a rudimentary level, students' use of multiple languages should be allowed, and their multilingual ability should be celebrated not suppressed. Additionally, teachers should recognize the value of multilingualism. As the participants explained, multilingual speakers can communicate and work with a wider group of people and help others who are less proficient in a certain language. When the environment is provided for them to work together with those who have different levels of proficiency in English and their first languages, they learn each other's language, how to articulate their ideas in different languages, when it is more appropriate to use one language instead of other languages, and how to make sense of the ideas of others who do not speak the same language as themselves. Language becomes a tool for thinking, learning, and communicating, rather than a learning goal itself imposed upon them. Code-switching in a learning environment is evidence of engagement rather than limited English proficiency, an indicator of their comfort in the setting, and an attempt to communicate and connect across linguistic boundaries. Also, multilingualism serves as a key component for playful banters among youths, which is an important element for participation and engagement. Teachers and other educators should acknowledge the value of multilingualism and provide a safe space for youths' use of rich linguistic resources.

Finally, the participants had developed a keen awareness of inequity, empathy for people who suffer from inequity, and critical minds for injustice. The youths cared about topics that are relevant to Chins and others who are disadvantaged and who had suffered inequity and injustice, and they were concerned about how local and global inequity can shape an individual's life quality. The youths started seeing

themselves as agents of change. We note that various equity issues that humanity is facing are closely related to school topics, such as water shortage, public health, and climate change, which all impact people differently depending on individuals' and their communities' socioeconomic status. There are ample possibilities where such topic areas can meaningfully engage refugee youths and develop the youths' critical literacy (e.g., Luke 2000; Roth and Barton 2004).

Conclusion

We might have started this research expecting to hear about challenges and hardships Burmese youths had experienced during their migration and in U.S. schools. The youths that we interviewed, however, told us different stories about their experiences, who they are, and how they want to change the world, and challenged our view. We realized that to a certain extent we were biased by dominant narratives about refugees. We urge other researchers and educators as well to not only focus on their deficits but also *our* failure to see multi-faceted life experiences that are full of struggles, tensions, hopes, and joys, and to recognize their strengths from their unique experiences. In this way, we hope to provide learning experiences that are empowering all students by both providing support for their needs and building on their strengths.

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Sacrificing Families: Navigating Laws, Labor, and Love Across Borders

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Guide to New Resources

Section Editors: Ming Fang He, Isabel Nuñez, Maria José Botelho, Cheryl E. Matias, Helen Maniates, and JoAnn Phillion

Sacrificing Families: Navigating Laws, Labor, and Love Across Borders

A review by Mavreen Rose S. Tuvilla
Purdue University

L. J. Abrego. (2014). *Sacrificing Families: Navigating Laws, Labor, and Love Across Borders*. Stanford, CA: 10 Stanford University Press. 250 pages, \$15.63 (paperback). ISBN 9780804790512.

In this book, Leisy J. Abrego sheds light on understanding the struggles of transnational and immigrant families. Today, there are 17.9 million school-aged children of U.S. immigrants (Zong & Batalova, 2017). The realities, pain, and sacrifices of the immigrant experience are arguably unfathomable for the White teachers who make up 86% of the total elementary and secondary U.S. teachers who teach an increasingly diverse U.S.

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Opinions expressed in this column do not represent views or official positions of the National Association for Multicultural Education (NAME). Similarly, reviewed resources carry no “official endorsement” by NAME. The authors are solely responsible for selecting and reviewing the resources featured in the column and we strongly encourage readers to examine resources prior to purchasing. Materials submitted for review in this column should be submitted directly to **Ming Fang He, Language, Culture, Identity, Power, and Place in Multicultural, Multiracial, and Multilingual Education, Department of Curriculum, Foundations and Reading, College of Education, Georgia Southern University, P. O. Box 8144, Statesboro, GA 30460-8144.**

classroom (Gay & Howard, 2000). Thus, there is a huge need for teachers to “attain new knowledge, paradigms, and perspectives on the United States and the world to deal effectively with both the challenges and opportunities of diversity” to become more effective teachers (Smith, 2009, p. 46). This increase in diversity has caused many educators to recognize the need to expand their knowledge of multicultural education in public schools (Nieto, 2004, as cited in Smith, 2009). A first step to becoming better teachers is the need for all teachers to “have the attitudes, knowledge, and skills to work effectively with racially, ethnically, linguistically, and socioeconomically diverse students” (Banks, 2004). In this sense, Abrego’s book is a valuable resource for U.S. school teachers to understand the struggles of the children of immigrants who are in their classrooms.

In this book, Leisy Abrego tackles the experiences of El Salvadoran transnational families and vividly captures the impacts of long-term separation. By gathering stories of families through casual conversations and observations and drawing heavily on 130 in-depth interviews conducted between June 2004 and September 2006 of parents and children of transnational families, Abrego analyzes the structural factors that forced Salvadoran parents to migrate, the harrowing details of their border crossings especially those who were not visa-authorized, and the consequences of U.S. immigration laws and the production of “(il)legality” to the transnational family. Abrego explores the transnational family strategy as a “response to economic circumstances” (p. 2) brought about by an unequal global economy and

discusses the emotional traumas that arise as ramifications of the transnational family strategy.

The book is comprised of eight chapters. In Chapter 1, "Salvadoran Transnational Families," Abrego provides the historical and political background of the Salvadoran migration experience highlighting how limited economic opportunities and implementation of neoliberal policies fomented the steady stream of migration to the United States. Of note is Abrego's mention of the U.S.-backed Dominican Republic-Central American Free Trade Agreement (CAFTA-DR) as key to the worsening of "inequality, increased inflation, decreased jobs, deteriorated labor rights, and less investment in social welfare programs" (p. 14) in El Salvador. In taking this stance, Abrego agrees with other scholars who find that the primary driving force of labor migration patterns are the inequalities in the global market (e.g., Czaika & de Haas, 2014; Holmes, 2013; Wade, 2004). This foregrounding was necessary in Abrego's argument that the transnational family strategy is a response to economic hardships.

In Chapter 2, "Why Parents Migrate," Abrego discusses the reasons why Salvadoran parents migrate and makes a case for the gendered reasons of migration. Abrego finds that men migrated to escape political threats and imminent danger brought about by the 1979 civil war in El Salvador. Abrego cites the U.S. government's involvement in the war as a key reason why the war lasted and spread extensively as it did. In contrast to men's migration patterns, women were forced to migrate for economic reasons as they were often single mothers and heads of their households.

In Chapter 3, "Journeys and Initial Settlement," Abrego discusses how the production of (il)legality through U.S. immigration policies and issuance of migrant visas and gendered inequalities impacts migrants even before they reach the United States. Those who travel without visa authorization go into debt to hire smugglers to help them cross three national borders to reach the United States and risk perils and violence in their journey. Gender determines how much debt one incurs; most men were more willing to cross the border by themselves, therefore, saving more than \$4,000 for the trip compared to women. Furthermore, in terms of safety, women experience a gendered disadvantage wherein they become easy targets of sexual abuse. Upon reaching the United States, gendered inequalities and the production of (il)legality continue to impact migrants. Undocumented travelers are unable to rely on their networks to ease their transition to the United States. Illegality makes them vulnerable to exploitation. They have to worry about paying off debts incurred in their journey and they are restricted to taking on poorly paid work. Gender determines what kinds of job opportunities are available to them with most women in lower status jobs, earning less money than men.

Chapter 4, "The Structure of Trauma Through Separation," captures how U.S. immigration policies determine the economic and emotional well-being of the transnational family. (Il)legality impacts the consistency of remittances or the money and goods immigrant parents send to El Salvador and, thus, determines how the children left in El Salvador fare. This directly impacts the emotional well-being of children left behind as remittances are viewed as reaffirmation of the parents' commitment to support their children. Remittances are arguably "a common strategy for engendering intimacy even if commodified, and interdependence in transnational families" (Parrenas, 2005, p. 317). Thus, when undocumented parents are not able to send remittances, their children not only suffer through poverty and the pain of being separated but also the insecurity that their parents are no longer committed to their welfare. In addition, (il)legality also structures the pathways to reunification of the transnational family. Since there are no legal pathways for reunification of undocumented parents and their children, this translates to a pervading uncertainty about whether reunification would even be possible. In this chapter, Abrego also discusses the consequences of the Temporary Protected Status that allows for some legal protection thereby affording a notable improvement on the economic aspects but offers no pathway to reunification thus little improvement of the emotional well-being of the transnational family. Abrego's analysis is in line with Menjivar's (2006) arguments that debates on immigration are complex and not just a matter of who is legal or illegal, who is documented or undocumented, but that an examination of the in-between legal statuses is warranted. The production of (il)legality creates a situation of "legal non-existence," stratification of belonging and access to legal protection, and has effectively produced a "population of longtime residents with suspended lives" (Menjivar, 2006, p. 1015).

In Chapter 5, "Gendered Opportunities, Expectations, and Well-Being," Abrego examines the gendered experiences of Salvadoran parents. Immigrant mothers receive less pay due to gender-stratified job opportunities. However, due to the existing societal expectations and gendered ideologies immigrant mothers choose to live in subsistence levels to send remittances consistently. Abrego's study revealed that Salvadoran mothers had to "[forsake] deeply felt beliefs that biological mothers should raise their own children, and [replace] that belief with new definitions of motherhood" (Wrigley, 1995, as cited in Hondagneu-Sotelo & Avila, 1997, p. 557). In adapting to this new conception of motherhood, Salvadoran mothers suffer labor exploitation and domestic abuse to prove their worthiness as mothers and fulfill patriarchal and Western ideas of womanhood. On the other hand, Salvadoran fathers had other ways to perform their masculinity (e.g., "virility, sexual prowess, and independence," p. 132) and, thus, were less compelled to

sacrifice more or remit more consistently. Abrego's work echoes Hondagneu-Sotelo's (1992) findings that although patriarchal gender relations are embedded in migration decisions (e.g., men are expected to be financial providers, women are expected to stay behind and care for the children), these are renegotiated and new patterns of behavior are initiated by the migration process itself. Hence, in this sense "migration is both gendered and gendering" (Hondagneu-Sotelo, 1992, p. 411).

Going beyond the economic implications of the immigration crisis, Abrego's book captures the heartwrenching and eye-opening stories of Salvadoran transnational families.

In Chapter 6, "How Children Fare," Abrego takes a closer look at the experiences of the children left behind in El Salvador. To capture the patterns of the children's economic well-being, Abrego focused on their access to food and schooling and developed three categories in a continuum: barely subsisting, surviving, and thriving. Those who belonged to the "barely subsisting" category were deprived of food, unable to attend school regularly, and had restricted access to healthcare. Those who belonged to the "surviving" category had enough money to cover food but had limited access to a college education. Finally, "thriving" children had access to food, private schooling, and extra money. Abrego noted that although half of her sample consisted of families who were thriving, in the overall landscape of Salvadoran transnational families, they were a small minority. What was even more compelling about the chapter was Abrego's analysis of the children's emotional well-being. Children whose parents were unable to send remittances and, thus, had little to show for their parents' absence in their lives were severely distressed while children who experienced financial advantages were better able to cope with the transnational family strategy. By juxtaposing the experiences of children who were barely subsisting and thriving, Abrego draws our attention to the depth of the existing inequalities and disrupts popular assumptions about the transnational family strategy.

In Chapter 7, "The Consequences of Long-Term Separation," Abrego examines the consequences of long-term family separation. Abrego's analysis demonstrated that children who struggled financially and emotionally exhibited resentment and were the ones most likely to rebel by misbehaving and/or doing poorly in school. Some purposefully did so as this was the only available way to hurt

their parents. There were also children who were so burdened financially and emotionally that they were unable to focus in school. Abrego found that children who did not experience the returns hoped for in a transnational family strategy often hinged their hopes on a future in the United States and were reluctant to pursue concrete educational/professional goals in El Salvador. On the other hand, children who experienced the fruits of their parents' labors that resulted in their upward social mobility preferred to remain in El Salvador. Thus, the effect of long-term family separation is jarring. For some families, reunification remains an impossible hope and both parents and children live suspended lives. Yet, even for families where family reunification is legally possible, the long wait for "legal papers" may have already made reunification too late.

In Chapter 8, "¿Valió La Pena?: Is Family Separation Worth It?," the final chapter, Abrego concludes her work by asking "Is family separation worth it?" The answer is a resounding "No." The transnational family strategy does not necessarily guarantee financial stability but the emotional trauma that comes with the long-term separation is an assured outcome. Abrego thoughtfully asks, "Are we comfortable being [a United States of America] that legally enables human rights abuses of migrants? What are we willing to do to stop the sacrificing of these families?" (p. 196). Abrego calls for policy changes that reflect a shift in valuing humanity over capital greed, where families no longer have to suffer through long term separation, and ultimately for "the right not to migrate" (p. 189). To answer Abrego's call for policy changes, there is a need to revisit what brought Salvadoran parents to decide to migrate in the first place. More equitable economic policies must be put in place. It is no surprise that the CAFTA (which was modeled after the failed neoliberal NAFTA model) has brought about economic instability and contributed to the immigration crisis instead of its touted aim of economic prosperity (Public Citizen, 2015). A far more challenging issue is the revamping of current U.S. immigration laws. This is a long arduous process but a good start is to evaluate the media discourse in reference to immigrants. Refugees, aliens, and immigrants are often depicted with metaphors of "quantification, tragedy, veracity and legality, crime and nuisance and movement" (Loring, 2016, p. 32). These dehumanizing portrayals have consequences to how public sentiment is shaped that can lead to political and social actions that often translate to policies.

This book is especially relevant today in the context of a United States of America led by a Donald Trump presidency intent on cracking down undocumented migrants. On January 25, 2017, President Trump signed "Executive Order: Enhancing Public Safety in the Interior of the United States" (Executive Order No. 13,768, 2017; Office of the Press Secretary, 2017) that authorized the Department of Homeland Security to deport

anybody without the correct papers. This directive has a significant impact on the estimated 570,000 El Salvadoran unauthorized migrants (Terrazas, 2010) and could potentially initiate the economic collapse of El Salvador. To put this in context, there are about 1.2 million people born in El Salvador currently living in the United States (Terrazas, 2010). In 2016, remittances sent to El Salvador amounted to \$4.6 billion, equivalent to 17% of the country's GDP, and one of the highest remittance rates in the world (Grillo, 2017). On the micro-level, Salvadoran remittances often go to the poorest families, clothing children, buying vital medicines, and helping old people who have no pension. On the macro-level, without remittances, poverty levels will rise, reduction in spending will occur which could lead to profit loss for companies resulting in unemployment and impacting government spending (Grillo, 2017).

Going beyond the economic implications of the immigration crisis, Abrego's book captures the heart-wrenching and eye-opening stories of Salvadoran transnational families. Readers are compelled to reconsider the discourse on migration and trouble the complex narratives of (il)legality, gendered migration experiences, and the consequences of long-term family separation.

As a researcher who works with resettled refugee youth, Abrego's book has helped me understand what the production of illegality might mean to the lives of the youth I work with. Although their contexts are different from the transnational families Abrego discusses in this book, I see commonalities in their lived experiences, such as the sacrifices their families had to go through in the hopes of family reunification. As an educator working in an increasingly diverse community, this book has deepened my understanding of the compelling need for an immigration reform and to look closer at the structural factors that force immigrants to immigrate. Furthermore, Abrego's book has added depth to my knowledge of the struggles that children of immigrants grapple with, struggles that directly impact their motivations to succeed in school. Abrego's book is a tool in my skills set as an educator dealing with multicultural issues in the classroom.

To order a copy of *Sacrificing Families: Navigating Laws, Labor, and Love Across Borders*, contact The New Press, 120 Wall Street, 31st Floor, New York, NY 10005. Tel: (212) 629-8802. Fax: (212) 629-8617. Website: <http://www.thenewpress.com/>

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Dismantling Cultural Beliefs, Policies, and Practices That Criminalize and Dehumanize Black Girls in U.S. Schools

A review by Alexandria Miller
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M. W. Morris. (2016). *Pushout: The Criminalization of Black Girls in Schools*. New York, NY: The New Press. 277 pages, \$14.66 (hardcover), \$18.95 (paperback). ISBN: 1620970945 or 9781620970942.

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