

**TEACHER SUPPORTS USING THE FACILITATOR MODEL FOR DUAL
CREDIT IN OPEN ENDED DESIGN THINKING COURSEWORK:
UNIVERSITY COLLABORATION AND HIGH SCHOOL
IMPLEMENTATION**

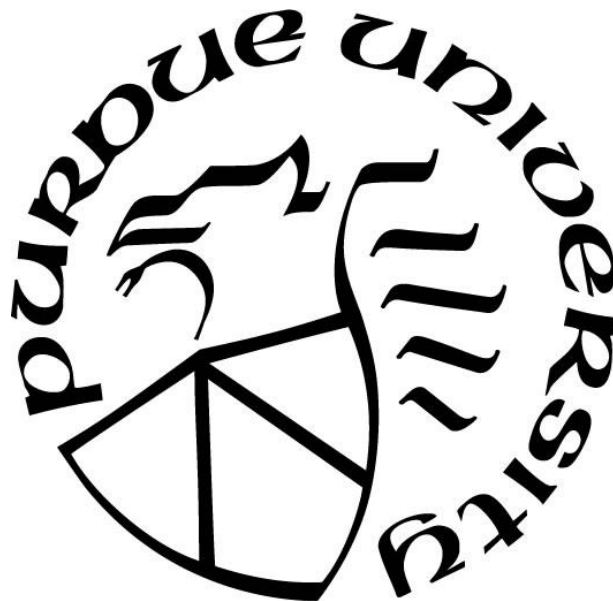
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A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science



Department of Technology Leadership and Innovation

West Lafayette, Indiana

May 2021

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Dedicated to Anna and Eleanor, for your ongoing love, understanding, and support.

TABLE OF CONTENTS

LIST OF TABLES	7
LIST OF FIGURES	8
ABSTRACT	10
CHAPTER 1. INTRODUCTION	12
1.1 Statement of Problem	12
1.2 Purpose of This Study	15
1.3 Research Questions	16
1.4 Scope	17
1.5 Definitions	18
1.6 Assumptions	19
1.7 Limitations	20
1.8 Delimitations	20
1.9 Summary	21
CHAPTER 2. REVIEW OF LITERATURE	22
2.1 Review of Literature Methodology	22
2.2 Defining Technology	23
2.3 How Technology Is Used in Industry	24
2.4 Design Thinking	25
2.5 The Skills Gap	26
2.6 Barriers to Closing the Gap	27
2.7 The Role of Secondary Schools	28
2.8 Dual Credit Models	29
2.9 For Whom Does Dual Credit Work?	33
2.10 Facilitator Model	34
2.11 Why the Facilitator Model Works	35
2.12 Contributing to Research on the Facilitator Model	36
2.13 Summary	37
CHAPTER 3. METHODOLOGY	38
3.1 Purdue's Collaborative Research Project Overview	40

3.2	Qualitative Research	42
3.3	Case Study	43
3.4	Sample.....	43
3.5	Preparation for Data Sampling.....	45
3.6	Instrumentation	48
3.7	Professional Development	49
3.7.1	Recruiting Teacher Facilitators.....	50
3.7.2	Professional Development Data Collection.....	53
3.8	Course Implementation Data Collection.....	56
3.9	Data Analysis	58
3.10	Role of the Researcher.....	60
3.11	Trustworthiness and Credibility	60
3.12	Researcher Bias	62
3.13	Summary.....	62
CHAPTER 4.	RESULTS	64
4.1	Purpose of the Study	64
4.2	Summer Training Program	64
4.2.1	Professional Development – Aligning with Purdue	65
4.2.2	Professional Development – Identifying Barriers	69
4.2.3	Professional Development – Planning for Ongoing Support	87
4.2.4	Professional Development – Professional Learning.....	95
4.2.5	On-going Support – Aligning with Purdue.....	126
4.2.6	On-going Support – Identifying Barriers.....	159
4.2.7	On-going Support – Provided Supports.....	170
4.2.8	On-going Support – Applications of Professional Learning	196
4.2.9	Positive Reception of the Facilitator Model	208
4.3	Summary	215
CHAPTER 5.	DISCUSSION	216
5.1	Conclusion	216
5.2	Recommendations and Implications for Practice	218
5.2.1	Aligning with Purdue.....	218

5.2.2	Barriers	220
5.2.3	Supports	224
5.2.4	Professional Development	225
5.3	Implications for the Field.....	229
5.4	Recommendations for Future Research	230
REFERENCES		232
APPENDIX A. INITIAL DATABASES SEARCH STRATEGY		244
APPENDIX B. BIBLIOGRAPHY OF MOST IMPORTANT INITIAL SOURCES		245
APPENDIX C. INITIAL RESEARCH VENN DIAGRAM		247
APPENDIX D. PERCEIVED NEED FLOWCHART		248
APPENDIX E. EVALUATING PROFESSIONAL DEVELOPMENT INSTRUMENT		249
APPENDIX F. DET INSTRUMENT TO EVALUATE UNDERSTANDING OF DESIGN THINKING		253
APPENDIX G. WILDER COLLABORATION INSTRUMENT TO MEASURE READINESS FOR COLLABORATION		255
APPENDIX H. RTOP OBSERVATION INSTRUMENT.....		258
APPENDIX I. PROJECT SPECIFIC QUESTIONS		264
APPENDIX J. LETTER OF COOPERATION		265
APPENDIX K. PARTICIPANT CONSENT FORM - INSTRUCTOR.....		266
APPENDIX L. TEACHER RECRUITMENT SCRIPT		268
VITA		269
PUBLICATION		273

LIST OF TABLES

Table 1 Matrix of Dual Credit Enrollment Categories	30
Table 2 Learner Analysis	44
Table 3 Performance Context Analysis	46
Table 4 Learning Context Analysis	47

LIST OF FIGURES

Figure 1. <i>Diploma Type Disparity</i>	13
Figure 2. <i>Percentage of High School Students Earning Early College Credit</i>	14
Figure 3. <i>Purdue’s Collaborative Research Project Gantt Chart</i>	39
Figure 4. <i>Professional Development Data Collection</i>	50
Figure 5. <i>Letter of Cooperation</i>	51
Figure 6. <i>Research Participant Consent Form</i>	52
Figure 7. <i>Teacher Recruitment Script</i>	53
Figure 8. <i>Summer Professional Development Schedule</i>	54
Figure 9. <i>Course Implementation Data Collection</i>	56
Figure 10. <i>Course Implementation Gantt Chart</i>	57
Figure 11. <i>Transcribed Data from this Study</i>	59
Figure 12. <i>Code to Theory Model for Qualitative Inquiry</i>	61
Figure 13. <i>Daily KWL Chart</i>	89
Figure 14. <i>Digital Gallery Walk</i>	107
Figure 15. <i>Digital Gallery Walk Comments</i>	108
Figure 16. <i>Google Jamboard Venn Diagram</i>	108
Figure 17. <i>Google Jamboard Brainstorming</i>	109
Figure 18. <i>Modified Assignment for Professional Learning</i>	110
Figure 19. <i>Rubric Practice Activity</i>	112
Figure 20. <i>Venn Diagram Comparison of High School and College Design Courses</i>	120
Figure 21. <i>Implementation Parking Lot</i>	121
Figure 22. <i>Slide Shared with Teachers to Explain Differences in LMS Courses</i>	128
Figure 23. <i>Student Checkpoint Feedback Email with Teachers</i>	133
Figure 24. <i>Identifying a Problem in the Community</i>	135
Figure 25. <i>Sketches and CAD Models</i>	135
Figure 26. <i>Cardboard and Rough Mock-ups</i>	136
Figure 27. <i>Functional Prototype</i>	136

Figure 28. <i>Google Calendar Pacing Solution.....</i>	138
Figure 29. <i>Adjusted Schedule</i>	139
Figure 30. <i>Final Project Gantt Chart</i>	140
Figure 31. <i>Purdue Checkpoints as they Appear on the Curriculum Side of the LMS.....</i>	142
Figure 32. <i>Example Student Email Template</i>	147
Figure 33. <i>Teacher-Created Supplementary Materials to Aid in Teaching Criteria and Constraints</i>	154
Figure 34. <i>Modified Agenda for Lesson Planning</i>	156
Figure 35. <i>Time Estimations for Preparatory Work</i>	167
Figure 36. <i>No Indication Group Assignments are Hidden from Students</i>	171
Figure 37. <i>Assignment Sample with Unclear Requirements due to Formatting</i>	185
Figure 38. <i>Supplemental Checklists to Interpret Rubrics</i>	190
Figure 39. <i>False Evaluations for Peers using CATME.....</i>	207

ABSTRACT

This research focuses on the teacher supports needed to implement university courses using a facilitator model approach to dual credit. This study runs parallel to a pilot program at Purdue that aims to provide a bridge for students who may otherwise feel that a four-year university is out of reach by providing directly transcribed dual credit and reducing required courses in the students' plan of study.

The facilitator model offers a unique approach to dual credit with the following three key features: secondary teachers that facilitate university curriculum, a Student Success Coach from the university who collaborates weekly with the secondary teachers, and an instructor of record from the university who allows for students to earn directly transcribed college credit. This model addresses many of the suggested changes to current dual credit models, including: ensuring credit transfer and articulation, affordability, accessibility, collaboration with the high school and college, and student supports. By addressing these barriers, successful incorporation of this model is likely to influence an increased enrollment and success of all students, including advancing equity for low-income and minority students.

Few studies, if any, have examined teacher preparation for and implementation of the facilitator model. Unlike other dual credit models that utilize a secondary teacher, a facilitator model enhances collaboration between high school and college instructors, and, if done well, ensures college credit transfer and articulation. This unique model situates the teacher with the crucial role of fostering student learning and navigating enrollment in the college registration (L. J. Pyzdrowski et al., 2011). This research has two main goals, to contribute to studies of the facilitator model in a complex project-based curriculum, and to identify supports needed by school districts and teachers if this were to be scaled up to other schools.

A qualitative case study was chosen to explore the needs of teachers as facilitators of college curriculum. Multiple interviews, focus groups, observations, questionnaires, and artifacts were triangulated and analyzed to draw conclusions on the needs of teachers through a summer professional development, and the implementation of the first year of the program. A thematic content analysis was conducted using both axial coding and code-recode techniques, with themes and data organized using NVivo software.

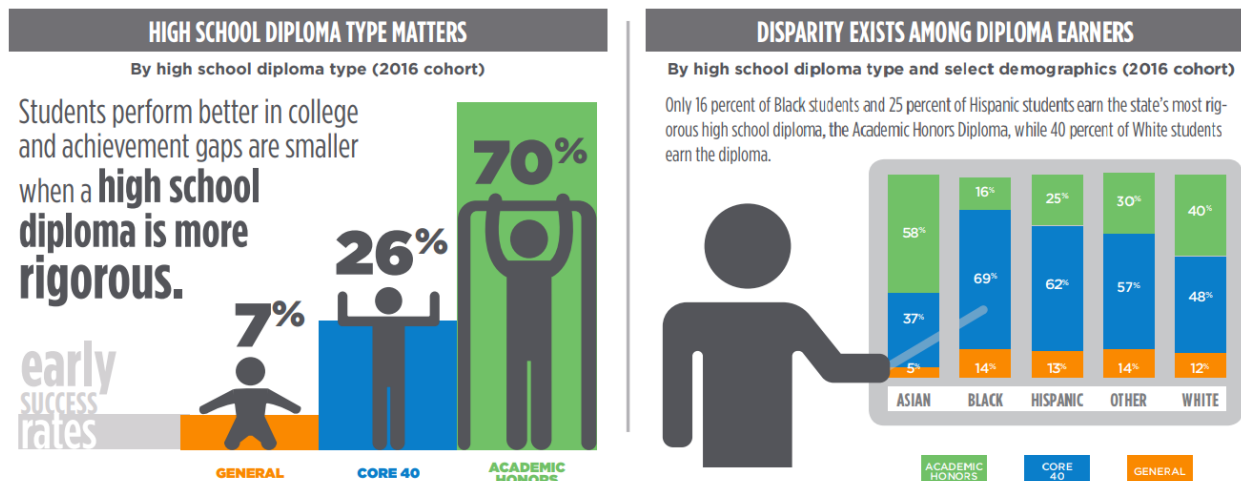
Successful implementation of the facilitator model for administering dual credit is expected to increase access of underrepresented students to dual credit programs as students receive directly transcribed grades that articulates with the college, there are strong communications between the teachers and university, students have the added support of a facilitating teacher, and barriers such as requirements for a masters or credit hours in the subject area are navigated around as the instructor of record is a faculty member from the participating university. Results include a discussion of recommendations for professional development and ongoing support essential to maintaining such a program. For higher education, implications of the facilitator model include a greater confidence in dual enrollment offerings, allowing for greater exposure to a wider variety of students. Implications for secondary schools might be to reach out to colleges and universities to collaboratively establish these facilitator model-based pathways.

CHAPTER 1. INTRODUCTION

1.1 Statement of Problem

Purdue has the second highest university enrollment in the state of Indiana (CollegeSimply, 2017) and is ranked fourth in the United States for international student enrollment (Purdue University Office of International Students and Scholars, 2019). While attendance at Purdue University in West Lafayette, Indiana continues to rise, there is a disproportionately low representation of minorities and low socioeconomic status students. Mitch Daniels, President of Purdue University, acknowledged this fact in 2016 in his statement “For this freshman class, we were only able to admit 26 students from the entire IPS [Indianapolis Public Schools] system. That’s unacceptable and someone has to find a way to do better” (Zink, 2016). The article goes on to state that out of 48,000 Indiana graduates in 2014, “only 101 African Americans and 156 Hispanics had SAT scores and GPAs in the range of the average Purdue freshman” (Zink, 2016). When compared to the total population of Indiana high school graduates, this reflects only 0.2% and 0.3% respectively.

A 2019 report from the Indiana Commission for Higher Education stated that of the 69% of all students across the state of Indiana to take the SAT or ACT, 79% earn a score high enough to indicate that they are college ready. When compared to their diploma type, correlations imply that their success is a direct reflection of the rigor of high school diploma type, which varies drastically by demographics (see Figure 1) (Indiana Commission for Higher Education, 2019).



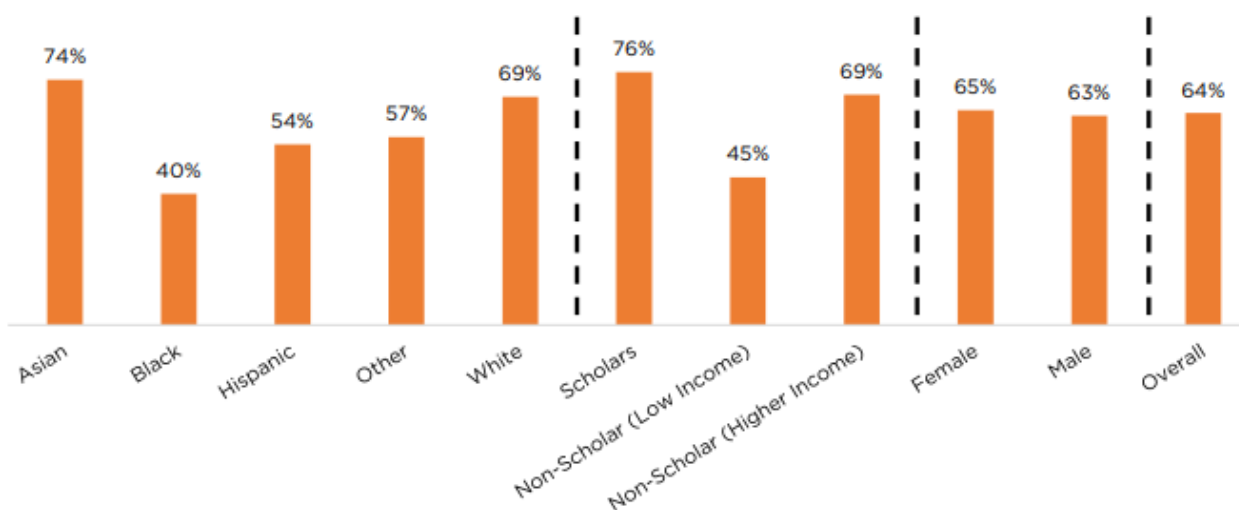
Note. Reprinted with permission from the 2019 *College Equity Report*, by the Indiana Commission for Higher Education, 2019 (https://www.in.gov/che/files/2019_Equity_Report_Placemat_8_22_19_Letter.pdf).

Figure 1. Diploma Type Disparity

The requirements for graduating with academic honors are largely dependent on completion of AP coursework or earning dual credits (Indiana Department of Education, 2016). Dual credit programs allow students to earn both high school credit as well as college credit, and include distance learning, college instructors at the high school, on campus enrollment in classes with college students, concurrent enrollment, on campus enrollment in classes solely for high school students, early college high schools, and hybrid models of online and classroom delivery methods. There is a great deal of research to support dual credit courses, including significant contributions in student success in post-secondary education by providing students with additional hours to complete course requirements, a higher likelihood of attaining a college degree, and free or discounted tuition (Abts, 2011; Bertram, 2006; Cowan & Goldhaber, 2015; Development Services Group, 2017; Indiana Commission for Higher Education, 2019; Lukes, 2014; Torres, 2019; Troutman et al., 2018). While nearly two-thirds of students are taking advantage of dual credit programs, there is still an underrepresentation of low-income and minority groups (see Figure 2) (Indiana Commission for Higher Education, 2019).

While many schools offer dual credit opportunities, they are not all taught in the same way. Some courses are taught by high school teachers with special certifications, some are taught on community college campuses, and a wide variety of courses are offered online. There are even

college preparatory high schools and charter schools that tailor their curriculum around credit earning opportunities (Cowan & Goldhaber, 2015). Just as the delivery methods of dual enrollment vary, so too do eligibility requirements such as grade level, GPA, and funding (Burns & Leu, 2019). This implies that the way in which the program is offered may be excluding the very students for which it would be most beneficial (Weissman, 2020). A 2019 report was published from a collaboration between The College in High School Alliance and Level Up, two coalitions made of national and state organizations that focus to increase representation of students of color, low income, and first-generation college students in post-secondary institutions. In their report they identified six (6) categories to consider for advancing equity and removing barriers when it comes to dual credit programs: statewide goals for engaging underrepresented minorities, ensuring credit transfer and articulation, affordability, accessibility, collaboration of high school and college instructors, and student supports (College in High School Alliance & Level Up, 2019).



Note. Reprinted with permission from the *2019 College Equity Report*, by the Indiana Commission for Higher Education, 2019 (https://www.in.gov/che/files/EquityReport%202019_FINAL.pdf).

Figure 2. *Percentage of High School Students Earning Early College Credit*

Weaknesses in current models for dual credit include a lack of collaboration between high schools and colleges, poor credit transfer, limited instructor capacity due to high qualifications, and a lack of supports as students make the transition from high school to college, especially

when they are a first-generation scholar (College in High School Alliance & Level Up, 2019; Horn et al., 2018; Weissman, 2020; Zinth, 2018).

A relatively new model for obtaining dual credit that addresses many of these concerns is the facilitator model. In this model, high school teachers receive summer professional development from, and work closely with, faculty from a four-year university to facilitate a current university course offering. High school students complete course content as students enrolled at the university, while receiving feedback from a university instructor of record who grades key assignments and projects, while the high school teacher facilitates the course. The university faculty member serves as the instructor of record, ensuring a direct transfer of credit. The Student Success Coach, another key component of this model (Pyzdrowski, 2020), works with high school facilitating teachers weekly, ensuring a fidelity of implementation to reduce the requirements needed, such as a master's degree in the subject area, to offer the class. This means that the facilitator model can support broader access to dual credit programs, especially ones that provide transcribed college credit. While this has shown promise in higher math education (L. J. Pyzdrowski et al., 2006, 2011, 2016), little research has been done in complex project-based curriculum, such as human-centered design. No evidence could be found that explores the needs of teachers and school districts when adopting such a model.

This study also speaks to the current discontent of students and their parents when attempting to apply credits earned for technology and engineering courses. Although students may earn credits through pre-engineering programs “no standardized educational program exists for pre-college students to earn widely accepted, transferable, engineering course credits” (Pines et al., n.d.), typically resulting in the credits neither contributing toward the students' plan of study nor helping to reduce their workload while in college.

1.2 Purpose of This Study

Purdue provides a number of options to help with a smooth transition of students, many first-generation college students, to the university including a collaborative program with multiple Indiana innovative public charter schools. This program utilizes a facilitator model of instruction wherein high school teachers collaborate with university faculty to facilitate Purdue curriculum with the same integrity and standards as would be found on campus. The course chosen for this

collaboration is TECH 120: Design Thinking in Technology, a required course for students majoring in any of over 40 possible career pathways (Purdue University, 2019b).

The facilitator model is unique in its approach to offering dual credit to high school students with multiple levels of support: the facilitating teacher, an instructor of record, and a Student Success Coach. While there is some support for this model based on student outcomes (L. J. Pyzdrowski et al., 2006, 2011, 2016), little research is available on the needs of teachers and school districts when adopting such a model. This research is needed to facilitate successful widespread access to effective dual credit programs that can help increase college enrollment of underrepresented students. The launch of this collaborative research program provides an opportunity to investigate the needs of teachers during professional development, and the level and type of ongoing supports they need throughout the school year. A successful implementation of TECH 120: Design Thinking in Technology will likely mean scaling up this collaboration to offer courses to more schools across Indiana, driving the need to identify supports needed for a sustainable program and positive experience for all involved.

The purpose of this study is to identify supports needed for professional development, successful implementation, ongoing support, and scale-up measures of a facilitator model using this collaborative research program. A qualitative case study was used to gather data from the piloting of TECH 120: Design Thinking in Technology through interviews, observations, questionnaires, and course artifacts.

1.3 Research Questions

There are multiple reasons why universities may not accept dual credit earned by high school students, especially if it is to replace pre-requisite course requirements (Horn et al., 2018). It is worth investigating two of the major arguments against granting credit. The first is a quality control perspective, that high school teachers do not have the same qualifications as instructors at the university (Hanover Research, 2014; Tobolowsky & Ozuna, 2016a; Troutman et al., 2018). How then can their grades and credit be justified? The second is that while the content may be adequate, the methods of delivery and instruction may vary. This is to say that if not taught the university way, that the student will not be prepared for upper-level classes that are meant to build on those methods (Hanover Research, 2014; Tobolowsky & Ozuna, 2016a; Troutman et al., 2018).

Quality control at the university includes a shift in academic workforce in higher education, such that nearly 30% of undergraduate courses at R1 universities were being taught by graduate students in 2016 (AAUP Research Office, 2018). Many of these students have limited teaching experience, and professional development typically lasts two weeks or less to prepare to teach their courses (Allison et al., 2014). To ensure consistency and quality of course instruction, it is especially important that full time faculty members acting as course coordinators to meet regularly to collaborate with instructors as a means of ongoing collaboration, support, and accountability.

The facilitator model is based on these support methods, incorporating a week-long professional development collaboration with high school teachers planning to facilitate the course, as well as ongoing support throughout the school year. This not only provides ongoing assistance throughout the year for the teachers involved, but also assures a fidelity of implementation for the university's approach to teaching (G. Strimel, personal communication, April 6, 2020).

The topic worth investigating here is what kinds of supports would someone with previous experience need? Are there initial differences in the first year of learning to teach a new curriculum? What kinds of professional development approaches and strategies are most effective? How will needs change throughout the course of the year? These questions can be summarized into the following two research questions:

1. How and in what ways did a one week-long professional development prepare teachers to teach a facilitator model dual credit course that emphasizes design and project-based learning?
2. How and in what ways does ongoing support throughout the academic year meet teacher needs in a design-based, facilitator model dual credit course?

1.4 Scope

This study addresses the role of high school teachers as facilitators of a college course with a project-based approach to open-ended problems. Teacher participants are limited to those acting as facilitators of TECH 120: Design Thinking in Technology from the two innovative urban public charter schools collaborating with Purdue University.

1.5 Definitions

The following terms have been identified as integral to this thesis document, and are defined as follows:

21st Century Skills: Core competencies that address ways of thinking, ways of working, tools for working, and living in the world (Binkley et al., 2012).

Advanced Placement® (AP®): College level courses and exams you can take in high school to earn college credit and skip introductory courses in college (*College Board*, n.d.).

CATME: The Comprehensive Assessment of Team Member Effectiveness (CATME) is a web-based system that aids instructors in managing teams of students by teaching them how to effectively contribute to teamwork by calculating accountability points for team-member contributions (CATME, 2008).

Design Thinking: Process for creative problem solving that uses a qualitative approach to identify people's needs with what is technologically possible (Brown, 2008).

TECH 120: Design Thinking in Technology: A curriculum that applies design thinking to technology related fields so students can use a constructivist approach to explore their environment to impact the world (Purdue University, 2020).

Dual Credit: Courses in which secondary students may earn both high school and college credits simultaneously (Indiana Department of Education, 2011).

Facilitator: Throughout this report, 'facilitator' will refer to the high school teacher who is responsible for daily instruction, while the 'instructor of record' is a university faculty member.

Facilitator Model: The 'facilitator model,' as used in this report, is a novel way of teaching a dual credit course. High school teachers work closely with faculty from the university to teach the same rigorous content/expectations as that of college students. The teachers act as 'facilitators' of instruction, while university faculty act as the 'instructor of record' to assign grades and provide feedback.

Human-Centered Design (HCD): An approach to problem solving that incorporates emotional and psychological preferences into tangible solutions for individuals, rather than seeking technical solutions to context-free problems (Gasson, 2003).

Innovation: Improvements made on existing products, systems, or methods of doing something (International Technology and Engineering Education Association, 2007).

Instructor of record: Throughout this report, ‘instructor of record’ will refer to the university faculty member who is responsible for evaluating student achievement and assigning grades. However, the course content will be taught by the ‘facilitator’.

K-12 Engineering Design: The adaptation of scientific and mathematical principles to practical applications in design, manufacture, and operation of systems, processes, structures, and machines (International Technology and Engineering Education Association, 2007).

STEM: An acronym for Science, Technology, Engineering, and Mathematics in education (Bybee, 2010).

Student Success Coach: A graduate student that will act as a liaison between the innovative urban public charter school and Purdue University to provide support and ensure a fidelity of implementation throughout Purdue’s collaborative research program. Responsibilities include providing grades and feedback on key projects and assignments, regular meetings with high school faculty, and virtual sessions with students and parents.

Transferability: For the purposes of this report, transferability will refer how easily a college credit earned in high school can apply to a student’s plan of study, reduce workload, and save time toward graduation.

Transfer credit: Credits earned in a dual credit course through one college or university, that a student then transfers to their intended college or university.

User-Centered Design (UCD): Goal-directed focus of tangible ways users will interact with solutions to technical problems (Gasson, 2003).

Under-Represented Minorities (URM): With respect to STEM fields, these are African-American, American Indian, and Hispanic students, as well as Asian female students (Bayer Corporation, 2012).

1.6 Assumptions

The following assumptions were made throughout this qualitative study with regards to teacher participants, methods and procedures, data analysis, and the outcomes of the study.

- Facilitators will answer truthfully on questionnaires.
- There will be a fidelity of implementation of TECH 120: Design Thinking in Technology.
- Facilitators have some basic fluency in design thinking instruction.

- Facilitators will be interested and engaged throughout the professional development process.
- The facilitators will be positive and encouraging about students considering the partnering University.

1.7 Limitations

The limitations associated with this study include the following:

- The assessment of needs and outcomes will be restricted to the content of Design Thinking in Technology and not focus on other contributing factors of the academic environment.
- The researcher cannot control for previous experience facilitators may have with Human-Centered Design or User-Centered Design that would influence needs or outcomes of professional development.
- Facilitator participants will be limited to two Indiana high schools who are participating in Purdue's collaborative research program.
- The time frame for this study is limited to approximately seven (7) months.
- The researcher cannot control the effectiveness of instruction from facilitators.
- The researcher cannot control for attitudes toward content and delivery of professional development.

1.8 Delimitations

The delimitations for this study are to include:

- Student success and achievement were not included in this study.
- This study does not investigate student intentions to matriculate to the partnering University.
- This study is not meant to differentiate individual needs based on various teaching backgrounds, but to identify any needs for successful implementation of a facilitator model for Design Thinking in Technology.

- This study does not investigate how facilitator model dual credit programs could be scaled up across the state of Indiana.
- This study does not investigate the retention rates of students who matriculate after successful completion of this facilitator model dual credit program.

1.9 Summary

This chapter provided an overview of the problems that schools face with current dual credit models, the scope and purpose of this study, and the research questions under investigation. A list of potentially unfamiliar terms was defined, and the researcher identified limitations and delimitations of the study.

CHAPTER 2. REVIEW OF LITERATURE

The purpose of this chapter is to justify the investigation of an alternative method for offering dual credit. After justifying a technology skills gap in industry defining the word ‘technology’ as both a product and a process, contributing factors are identified, and logical conclusions are drawn between the drop-out rate of college students, and the way in which they were prepared for college level material in high school. It is found that the more prepared students are, the more likely they are to complete their college degree, justifying the need for dual credit opportunities in high school. Issues with current dual credit models are identified, and a justification for the facilitator model is presented. Little evidence of research could be found specifically on this model, and no research could be found in its application outside of math courses or the needs of teachers when adopting such a model. The chapter starts with a review of literature methodology to investigate and introduce the facilitator model.

2.1 Review of Literature Methodology

While secondary schools offer pathways for student to receive college credit for AP and STEM courses, students are rarely presented with opportunities to earn technology or engineering related credit. In fact, “no standardized educational program exists for pre-college students to earn widely accepted, transferable, engineering course credits” (Pines et al., n.d.). Programs such as Project Lead the Way offer pre-engineering credit through several universities (Hughes, 2017), but there are major barriers to reducing class load or time to graduation by the application of credit to a student’s plan of study. While it has been found that students are better prepared for higher education classes, credit is often not awarded or given in the form of a general elective, neither contributing toward the undergraduate plan of study nor helping reduce their workload (Troutman et al., 2018). This leads to discontent with both college students and parents.

Much can be learned from identifying the barriers regarding transfer of credit when applied to technology related courses. This review of literature will define technology, identify the ways it is being used in industry, highlight the need for human-centered design and shortage of workers in industry, identify barriers to providing necessary skills, and explore the ways in

which we can strengthen the bridge from high school to college. The focus of this study is a new model for providing college credit to secondary students known as the facilitator model. While the facilitator model has proven successful in preparatory math courses (L. J. Pyzdrowski et al., 2006, 2011, 2016), little has been done to investigate the fidelity of implementation for technology or design related subjects with a complex project-based curriculum.

Several measures were taken to provide a high-quality review of literature on the facilitator model. This includes a comprehensive search of peer-reviewed journals, theses, dissertations, and interviews using the search string ‘(Facilitator OR Blended Modality OR Co-teaching Model) AND (Professional Development OR Teacher Training OR Summer Training) AND (Dual Credit OR College Credit OR Transfer Credit)’. Databases utilized include the Education Commission of the States, EBSCO, Engineering Village, ERIC, Google Scholar, JSTOR, ProQuest, Sage, Scopus, Springer Link, U.S. Department of Education, and Web of Science (see Appendix A). References cited from each article were also searched to find additional supporting material, and interviews were conducted to gain more information about professional development, teacher needs, and the facilitator model. Over 26 high-quality, peer-reviewed articles have been identified to inform practices on professional development, college/dual credit, and the facilitator model (see Appendix B), and graphically organized into a Venn diagram (see Appendix C). These references were specifically cited to both generate and address the needs of high school teachers as facilitators for a successful implementation of a human-centered design/design thinking course (see Appendix D).

2.2 Defining Technology

In order to situate the application of a facilitator model in Tech 120: Design Thinking in Technology, we must first define technology. Richard Rhodes stated, “Technology is the application of science, engineering and industrial organization to create a human-built world” (Rhodes, 2012 p. 19). David Kaplan more thoroughly defined it as:

Technologies are best seen as systems that combine technique and activities with implements and artifacts, within a social context of organization in which the technologies are developed, employed, and administered. They alter patterns of human activity and institutions by making worlds that shape our culture and our environment. If technology consists of not only tools, implements, and artifacts, but also whole networks

of social relations that structure, limit, and enable social life, then we can say that a circle exists between humanity and technology, each shaping and affecting the other.

Technologies are fashioned to reflect and extend human interests, activities, and social arrangements, which are, in turn, conditioned, structured, and transformed by technological systems. (Kaplan, 2012, p. 167)

It is important to see that technology can be more than a product; it can also be an active process that systematically solves problems encountered in everyday lives. Similarly, technology is not only the application of scientific principles, but provides the tools for scientific discovery.

2.3 How Technology Is Used in Industry

There is nothing that has done more to flatten our world and remove the boundaries created by the natural geographical barriers than the widespread use of the internet. When analyzing Friedman's ten (10) suggested 'flatteners' of the world, only one, the fall of the Berlin Wall, does not rely on collaboration and communication tools provided through the integration of the world wide web into an increasingly networked world (Friedman, 2005). While the world has continued to change in the 15 years since the release of his book, the principles of technological advancements, fueled by online collaboration still hold true. Worldwide collaboration and shared information have resulted in advances across the board from the National Academy of Engineering's 'Grand Challenges in the 21st Century' (National Academy of Engineering, 2020) including education, infrastructure, and tools of scientific discovery.

While consumers see increasingly creative uses for 'smart' devices, social networking, and recreational technologies such as drones and 3D printing, industry has taken it to another level. Many tasks that used to rely on human workers and judgement is being outsourced to automated processes where businesses have more control over the speed, consistency, and quality of the product being produced. This is done by the incorporating such things as cameras for image recognition, sensors to detect environmental variables, analysis of 'big data' as a tool for both diagnostics and prediction, and drones as both a tool for distribution and data collection (Arnold Machine, 2015; Cloud Computing, 2017; Ismail, 2018; Leary, n.d.).

The advances in technological products have and will continue to shape the world in which we live, while design thinking is the process that enables technology to happen. "Design thinking

provides a structured process that helps innovators break free of counterproductive tendencies that thwart innovation” (Banga, 2019).

2.4 Design Thinking

With the variety of ways to collect, analyze, and compare data, making informed decisions seems easier now than ever before. In fact, a global economy provides seemingly unlimited solutions to a variety of problems on a daily basis, which often makes finding the ‘best’ solution problematic. One effective way to find comparable solutions and adapt them to a unique problem space is to implement a process known as design thinking.

Design thinking is a method of systematically solving problems while utilizing a concept known as Human-Centered Design (HCD). As the name implies, HCD always takes the user into consideration throughout the problem-solving process so that the technology developed meets their needs and satisfies their frustrations. Design thinking is broken down into three main phases: inspiration, ideation, and implementation (Torabi, 2020a).

Inspiration is arguably the most important of these three phases, as it is where empathy is developed for the user by taking a deep dive into what they see, say, do, hear, and think (Torabi, 2020c). Understanding the end user, what their problems are, and what it will mean to them once they have a solution to their problem, will impact the focus of observations, the questions asked in interviews, the research done on pre-existing solutions, the final product design, and the way in which the product is marketed. The inspiration phase relies heavily on ethnographic practices, building upon techniques utilized to validate the studies of qualitative researchers (Goetz & LeCompte, 1981; Lincoln & Guba, 1985; Wilson & Hutchinson, 1991).

The ideation phase is composed of two main steps: idea generation and concept development (Torabi, 2020b). Idea generation, known in other design processes as the brainstorming phase, is used to generate many potential solutions to a problem, prioritizing quantity over quality. Participants should be familiar with the target consumer and the research collected during the inspiration phase. It is recommended that individuals ideate on their own before contributing their ideas to a group to prevent relying on others while promoting buy-in of the final solution (Torabi, 2020b). Group brainstorming should be done at a fast pace for a short period of time to generate anywhere from 50-100+ ideas, with more time spent on concept development. Concept development should be done with smaller groups than that of idea

generation, while working to narrow down the ideas generated in brainstorming into no more than a dozen concepts for further consideration and refinement. These concepts should address the identified need of the consumer, how it contributes to a solution to meet that need, what the end product would look like, and how the user is to benefit from the proposed solution (Torabi, 2020b).

In the final stage of implementation, solution validation through prototyping and testing on individuals who represent the target consumer become the main focus. This is done through iterative testing loops of making assumptions, prototyping designs, and running experiments to test the design (Torabi, 2020d). The mindset to be employed during this phase is inspired from a quote by John C. Maxwell, "The only way you can get ahead is to fail early, fail often, and fail forward" (2007, p. 113). This encourages multiple iterations of low cost, low risk prototypes with a representative from your target audience for constant adaptation and feedback (Torabi, 2020d).

A study from 2015 identified that over 150 companies have integrated design thinking into their daily practices (Schmiedgen et al., 2015). These businesses ranged from small startups to large international companies, and while most sectors were predominately information and communication based, many sectors were represented. Many studies, journals, and even TED Talks have acknowledged that empathizing with the customer, and making seemingly small changes to your business plan, can have large impacts on customer satisfaction and ultimately profits (Brown, 2008; Burke, 2014; Galveski, 2015; Liedtka, 2018; Lockwood & Papke, 2017; Schmiedgen et al., 2015) driving the demand to incorporate it into a wider variety of practices.

The success of design thinking as a business model, technology, and strategy to find the right technology for customer needs has created a following and demand for design thinkers. Unfortunately, the supply of people who are qualified in the most up-to-date industry technology are low, and those that are skilled in design thinking even lower.

2.5 The Skills Gap

Studies show that there are a shortage of skilled trades workers in fields such as construction, manufacturing, information technology (Davis et al., 2012; Leary, n.d.; Morrison et al., 2011; Wu et al., 2019). In a 2019 survey, 83% of business owners interviewed stated that they had trouble recruiting candidates due to such things as competition with other businesses, a

lack of the necessary skillsets, and a low number of applicants, while citing trade skills carpentry, plumbing, welding, machining as the top missing skills (Burner et al., 2019). This is in line with what we see from Purdue University's Polytechnic Institute, which has had 91.4% placement rate (Purdue University Polytechnic Institute, 2019) even after record enrollment numbers for the third year in a row and 4910 Polytechnic students in the Fall of 2019 (O'Malley, 2019).

While technical skills are in demand, much of the literature stresses a higher need for students with 21st century skills, sometimes referred to as soft skills, such as problem solving (Burner et al., 2019; Hora, 2017; Penrod, 2019) with some studies even citing it as the number one skills deficiency among employees (Morrison et al., 2011). It is far easier to find employees that have experience with a technical skill or programming language than it is to find one that is adaptable and can communicate, collaborate, and problem solve (Schirf & Serapiglia, 2017), and it is the innovation and decision making with messy problems that is most desired (Ras et al., 2017).

We have known of the skills gap for over a decade, and yet it persists. Advances are being made by universities, businesses, and schools to close the gap, while a number of barriers still exist that inhibit progress.

2.6 Barriers to Closing the Gap

The skills gap has been well documented for over three decades (Eisen et al., 2005; Morrison et al., 2011; National Association of Manufacturers et al., 2003; National Center on Education and the Economy, 1990, 2008; Penrod, 2019; Schirf & Serapiglia, 2017), and while efforts have helped to lessen the impact, it is still impacting our economy and workforce. This is partly due to the fact that there is no single contributing factor, but a series of interconnected obstacles.

There is a wave of retirements from experts in the field (Wu et al., 2019) and a change of complexity in the workplace, a shifting of job profiles (Ras et al., 2017; Schirf & Serapiglia, 2017), which is even more troubling we find less applicants for these positions (Burner et al., 2019). Some suggest that the skills students are graduating with are not representative of what is needed (Cappelli, 2015; Weaver & Osterman, 2016), while also noting that those with the skills

may not be willing to take certain jobs because they are unsatisfied with the amount employers are offering to pay (Abraham, 2015; Cappelli, 2015).

While not directly related to the skills gap, one avenue worth investigating is the fact that approximately 40% of college students drop out before finishing college, with 30% dropping after their freshman year (Bustamante, 2019). Among the many reasons for not completing their degree, dissatisfaction with their field of study and being unprepared academically are significant contributing factors (Bustamante, 2019; Hess & Hatalsky, 2018). Students who are dissatisfied with their field of study often find themselves changing majors, adding to the amount of time to complete their degree and increasing financial pressure which in turn increases their risk of dropping out (Bustamante, 2019). Fortunately, secondary schools can aid in the transition and retention of students, while also giving them a chance to investigate programs of interest at a minimal risk.

2.7 The Role of Secondary Schools

High school students can participate in courses that have positive effects on their overall academic achievement, completing high school, gaining access to college, retention in college, and degree attainment, all while earning college credits at low to no cost (Development Services Group, 2017; Indiana Commission for Higher Education, 2019; Lukes, 2014). These courses go by many names, such as early college credit, concurrent enrollment, post-secondary enrollment opportunities, early college programs, and most commonly, dual credit (Indiana Department of Education & Commission for Higher Education, 2019; Troutman et al., 2018).

Dual credit courses are required for advanced diplomas by many states, including Florida, Georgia, Indiana, Ohio, Virginia, and Washington (Indiana Department of Education, 2016; Kelley & Rowland Woods, 2019), which is significant as strong correlations have been found between the rigor of diploma and success in high school (Indiana Commission for Higher Education, 2019). While dual credit courses vary in content and structure, a Texas study involving 129,661 students and 533,046 courses found that “Exposure to any college course has a positive impact on student retention and graduation” (Troutman et al., 2018, p. 33). This claim was further substantiated by the findings that students who completed dual credit coursework were twice as likely to complete their first two years of college than their noncredit bearing peers (Troutman et al., 2018).

There are many benefits to student participation in dual credit courses, and while researchers strongly recommend statewide accessibility, many states leave this decision to local districts. Only fourteen (14) states have mandatory statewide policies on dual credit offerings by postsecondary institutions, guaranteeing student access to higher education regardless of location (Kelley & Rowland Woods, 2019). It is important to note that while many programs may fall under the broad category of ‘dual credit’ the requirements for participation, delivery, transferability of credits, and location can vary greatly.

2.8 Dual Credit Models

There are a wide variety of dual credit models. Students can take courses from a two (2) year college or four (4) year university, and the location of courses can also vary, as students can take their courses online, on site, or from a faculty member of their high school. There is also an assortment of names for each model, and advantages and disadvantages to adopting each one. As a reference, it is suggested that they can be grouped into three main categories: singleton programs, comprehensive programs, and enhanced comprehensive programs (see Table 1) (Bailey & Karp, 2003; Cassidy et al., 2010; Fowler & Luna, 2009).

Table 1*Matrix of Dual Credit Enrollment Categories*

	Singleton	Comprehensive	Enhanced Comprehensive
Target Student	Academically proficient	Middle achieving	Middle to low achieving
Location	High school	High school College	High school College
Student Mix	High school only	High school only Mixed with college	High school only
Instructor	High school College	High school College	High school College
Course Content	Special curriculum College curriculum	Special curriculum College curriculum	Special curriculum
Credits Earned	Exam-based Course-based In-escrow	Exam-based Course-based In-escrow	Course-based
Degree of Intensity	Low – just one of many educational experiences had by students in their junior or senior year	High – the primary educational experience during the last years of high school	High – addresses social and behavioral, as well as academic, needs

Note. Recreated with permission from *Promoting College Access and Success: A Review of Credit-Based Transition Programs*, by Bailey & Karp, 2003, p.14. From <https://files.eric.ed.gov/fulltext/ED482497.pdf>.

Singleton programs are the most common form of dual credit across the US (Bailey & Karp, 2003), and consist of elective courses that students can enroll in to experience the rigor of college courses while earning college credit. The most popular examples include the AP program, pre-engineering programs such as Project Lead the Way and Engineering by Design, and other career and technical programs.

While singleton programs are designed to let students experience college courses for a short period of time at a low risk, comprehensive programs are more involved, taking up the majority of the student's junior and senior year (Bailey & Karp, 2003). Examples range from programs such as the International Baccalaureate or IB program, a rigorous multi-subject curriculum recognized by universities worldwide, to lesser known Tech Prep programs (Bailey & Karp, 2003).

Enhanced comprehensive programs, such as middle college high school (MCHS) and other college preparatory schools offer an even more rigorous experience for students, often going beyond classroom instruction to include individual counseling, tutoring, and assistance with applications (Bailey & Karp, 2003). Though the least common, they offer the greatest return on investment, especially for lower achieving students.

When incorporated into a secondary curriculum, Tech 120: Design Thinking in Technology is most similar to a singleton program, as it has no pre-requisites or post-requisites for participation. Therefore, it is most important to focus on strengths and weaknesses of various models of singleton programs, including the degree to which they vary in instructors, location, eligibility, tuition, student population, and intensity (U.S. Department of Education, 2003). While not a comprehensive list, the next several paragraphs provide a broad overview of the most widely accepted dual credit models.

Advanced Placement Testing (AP) – Students enroll in subject specific advanced placement courses through their high school, courses are taught by certified high school teachers, and a standardized test is administered at the end of the year to determine if college credit should be administered. Scores on these tests range from 1 – 5, and students only get high school credit with a score of 3 or above, while it is at the discretion of each university to set an acceptable score for college credits (Delicath, 2000).

Concurrent Enrollment – Similar to dual enrollment, students enroll in college classes that are taught at their high school and count for both college and high school credit, however, costs are covered between the high school and the participating college (Merren et al., 1997).

Co-op Courses – Courses taught at the high school by high school teachers who meet specific criteria. Upon successful completion, students earn credit through the cooperating college (Rajala, 2003).

Course Articulation – Courses are taught at the high school, but an intergovernmental agreement is signed to acknowledge that student performance must be equivalent to or exceed that of the college counterparts. Students do not receive the articulated credits until they enroll at the participating college and complete an agreed upon number of credits (Merren et al., 1997).

Curricular Alignment – This model involves high school teachers working with college instructors to modify and align their curriculum to parallel that of the college coursework. While students do not receive college credits, they may waive pre-requisites for post-secondary courses, allowing them to advance more quickly through higher level content (Merren et al., 1997).

Dual Enrollment – Students in the dual enrollment model qualify for credits through both their high school and the participating college and cover the cost of their tuition, often at a reduced price. Courses may be taught at the high school by a qualified teacher, or at the participating college or other off-site location by an instructor from the college. The term ‘dual enrollment’ stems from the fact that students are enrolled at the participating college while still in high school (Merren et al., 1997).

Prior Learning Assessment (PLA) – Students who feel they are already proficient in college level material may take a standardized test called a College-Level Examination Program (CLEP). Tests are taken at an accredited testing location, and scores are reported to colleges (Indiana Commission for Higher Education, 2020).

Shared Curriculum/Intensive Dual Enrollment – Junior and senior year of high school is treated as the first two years of a four-year program that culminates in an associate’s degree. Coursework counts toward both high school credit and a foundation for the student’s plan of study in college (Heath, 2008; Merren et al., 1997).

Tech Prep Credit – An articulation agreement from universities targeting students who focus on technical subjects while in high school. Students earn high school credits immediately, but only earn college credits after matriculating to the participating college (Bailey & Karp, 2003).

Virtual-College Credit Courses – On-line courses students can participate in from the university along-side college aged students. Colleges are able to award directly transcribed credit, while students are often able to use credits earned toward their high school diploma (Hoffman, 2010).

Clearly there are a wide variety of program models schools may offer for students to earn college credit while still in high school. Advantages from participation in such programs has already been established, but each model has caveats for students, parents, school districts, colleges. Dual credit works, but it may not work the same for everyone.

2.9 For Whom Does Dual Credit Work?

As a college, school district, or student, there are decisions to be made regarding participation in dual credit programs, especially when considering resources such as time, money, and effort required for a positive outcome. There are also unintended outcomes from various policies, leading to underrepresentation of low income and minority students. This section is intended to draw attention to what is not working with current dual credit models and identify ways in which they may be improved.

With all of the advantages students receive from successful completion of dual credit courses, it may be surprising to find that many are dissatisfied with the opportunity. Some expressed a disconnection with their teachers and peers (Taylor & Pretlow, 2015), while a larger contributing factor relates to the credits earned through such a program. Students express frustration when under the impression that by earning credits in high school, they can enter college a semester, or even a year ahead, only to find out that many did not count to their plan of study and they are starting the same place as every other freshman (Taylor & Pretlow, 2015). Even for well-established programs such as AP, “86% of the top 153 universities and colleges in the United States restrict the awarding of AP credit” (Weinstein, 2016, p. 2).

Some colleges worry about the rigor and fidelity of implementation (Hanover Research, 2014; Tobolowsky & Ozuna, 2016a; Troutman et al., 2018). While as many as twenty-five (25) states require dual enrollment credits to transfer to both two-year and four-year universities (Zinth, 2016), many do not have a policy regarding transfer of dual credit earnings. In the past, some schools have gone as far as to ban any credit from dual enrollment courses altogether (American Association of State Colleges and Universities, 2002). In an effort to bring more accountability on the part of the schools, some programs require high school teachers to hold the same qualifications as the college level instructor, including a master’s degree in their field of study (Tobolowsky & Ozuna, 2016a; Troutman et al., 2018).

Low income and minority populations are particularly underrepresented in dual credit coursework participation (Hoffman, 2010; Indiana Commission for Higher Education, 2019; Zinth, 2014). While many factors may prevent access to these programs, financial support and a shift in program priorities play key roles (Hanover Research, 2014; Zinth, 2014, 2018). Dual credit provides the opportunity for students to take challenging, college level courses with the support of high school teachers, and was originally intended as a pathway for these mid-achieving students that may not have considered going to college (Chatlani, 2018). Without direction from the state, and with restrictions on teachers qualified to teach the courses, schools have over time made the transition to focus only on students who were already college bound, discouraging those who may benefit most (Chatlani, 2018; Zinth, 2014, 2018). Magnifying the issue of access, not every school is willing to financially support students for courses outside of their regular offerings, leaving fees ranging from \$85 to \$600 for the families to pay (Bertram, 2006; Tobolowsky & Ozuna, 2016b; Troutman et al., 2018).

Although the gap remains for low income and minority students, research has drawn attention to unintended barriers and proposed new models to overcome them. The facilitator model is one such dual credit program.

2.10 Facilitator Model

Combining elements of the well-established dual enrollment and co-op courses with unique attributes of its own, the facilitator model for dual credit presents a new approach for a successful transition of students from high school to a four-year college or university. The three main aspects of this model are teacher professional development, implementation of a Student Success Coach, and a separation of high school and college grades.

Over the summer teachers receive professional development from a cooperating university on the structure, rigor, and methodology of the course to be offered. Teachers are provided with a set of the course's curriculum outlining daily plans, assignments, quizzes, projects, and rubrics, with an expectation of fidelity of implementation (L. J. Pyzdrowski et al., 2006, 2011, 2016; G. Strimel, personal communication, April 6, 2020).

Throughout the school year, a Student Success Coach from the university grades and provides feedback on key projects and assignments to students and meets with teachers on a weekly basis. Weekly meetings provide planning and support for future weeks, while also

monitoring success of students in the case that they may need to withdraw to protect their college GPA (G. Strimel, personal communication, April 6, 2020).

Teachers facilitating the course provide grades and feedback to students in parallel to the Student Success Coach so that high school and college grades can remain separate. Deidentified rubrics and comments made to students from both the teacher facilitator and the Student Success Coach are compared at weekly meetings for consistency and clarity. At the end of the course, the college faculty member is listed as the instructor of record for directly transcribed college credit at a reduced cost to students (L. J. Pyzdrowski et al., 2006, 2011, 2016; G. Strimel, personal communication, April 6, 2020).

2.11 Why the Facilitator Model Works

By incorporating a Student Success Coach, the facilitator model addresses many concerns that universities have with accepting dual credit from high school students (Hanover Research, 2014; Tobolowsky & Ozuna, 2016a; Troutman et al., 2018). Consistency and quality are maintained, there is a fidelity of implementation, and grades are assigned by a college faculty member, allowing for directly transcribed credit. In addition, by having the high school teacher facilitate the course, and instructor of record award the credit, the qualifications of facilitators (Horn et al., 2018) can be relaxed, allowing for more flexibility in course offerings.

Student discontent with application of credits is also addressed, as courses in previous studies, and with this collaborative program, are strategically selected to be required for the student's plan of study (L. J. Pyzdrowski et al., 2006, 2011, 2016). This is likely to continue to be true of future course offerings with the facilitator model, as the demand for resources to support schools drives a need for relevance to students and the university.

Research suggests that additional barriers to overcome in order to be more inclusive of low-income and minority students include affordability, accessibility, and student supports (Chatlani, 2018; Hanover Research, 2014; Indiana Commission for Higher Education, 2019; Light, 2016; Zinth, 2014, 2018). The facilitator model allows universities to work strategically with schools that will benefit most, while providing students a dual avenue of support through the success coach and their normal high school teacher. While courses are still offered at reduced cost to the students, they are made affordable to the point where families and school districts may be willing to invest in the opportunity.

There is promising evidence from the research available on course outcomes using the facilitator model, showing high school students outperforming their university peers, and continuing their success in subsequent coursework once matriculating to college (L. J. Pyzdrowski et al., 2006, 2011, 2016). An interview with a program administrator of the Pyzdrowski study confirmed student performance, and went on to cite an increase in enrollment of over one thousand (1000) students after the first year using the facilitator model, with students feeling stronger connections to the university (G. Strimel, personal communication, April 6, 2020).

2.12 Contributing to Research on the Facilitator Model

There is much research on what needs to be done to improve current dual credit opportunities for students (Chatlani, 2018; Hanover Research, 2014; Indiana Commission for Higher Education, 2019; Light, 2016; Zinth, 2014, 2018). However, after an extensive literature review, many dual enrollment program models remain unchanged, and few articles could be found proposing alternative models when offering dual credit opportunities, especially for four-year universities. Furthermore, the literature that could be found in support of models such as the facilitator model (L. J. Pyzdrowski et al., 2006, 2011, 2016), focus only on student outcomes and not on the support of teachers or school districts in adopting and implementing these programs. Finally, the research supporting the use of the facilitator model for dual credit opportunities is in high school math education (L. J. Pyzdrowski et al., 2006, 2011, 2016). While the facilitator model shows promise in this field, more research is needed to see if it can apply to a complex project-based curriculum.

It is therefore the focus of this research to contribute to the discussion of alternative dual credit models and investigate professional development and supports needed when introducing a new model to a group of teachers and a school district. The curriculum chosen for this study, Tech 120: Design Thinking in Technology, focuses on a human-centered design approach to problem solving, both a highly sought-after skill from an industry perspective, and a complex project-based curriculum such that there are many possible answers to any given problem. It is strategically chosen as a required course for any student at the Purdue Polytechnic Institute, addresses core requirements for other university majors, and is one of three courses needed for a Design and Innovation minor.

2.13 Summary

A short discussion of literature research methods was used to establish credibility for the researcher before providing justification for the context and potential impact of this study. To do this we first defined technology as not just a product but a process, and investigated a skills gap in industry with both skills using products, and problem solving processes. Barriers to closing the skills gap were identified as well as the position that secondary schools are in to contribute to a solution. Dual credit was identified as a significant factor in the success of students interested in pursuing a college degree. Reasons why students may abstain from participation in these programs were also presented, along with a number of contributions by experts in the field on how to make the experience more inclusive to any student motivated to try a more rigorous course. Finally, an alternative model was introduced that incorporated many of the suggestions for a more inclusive and supportive dual credit experience, known as the facilitator model. Support for the model was presented, and promising statistics were shared regarding student outcomes. An extensive search revealed that little has been done in terms of research on this model, and no evidence could be found on the needs of the cooperating school or teacher facilitators, justifying further research contributions.

CHAPTER 3. METHODOLOGY

This chapter discusses specific qualitative research practices employed while investigating the implementation of a facilitator model for dual credit opportunities for high school students through Purdue's collaborative research program. The course used for this facilitator model for dual credit is Tech 120: Design Thinking in Technology, a first year design course at Purdue university focused on human-centered design. This course is a requirement for all students enrolled in the Polytechnic Institute. The course consists of three major projects over a sixteen (16) week period, delivered in such a way that each project provides scaffolding for the next as major assignments are repeated with added depth at each iteration. Included in this chapter are methods of observations, semi-structured interview questions for both individuals and focus groups, and questionnaire items, while also taking into account the sample size, sites for data collection, data collection procedures, and the role of the researcher. Purdue's collaborative research project took place over twenty-eight (28) weeks, starting in June, and concluding at the end of December (see Figure 3).

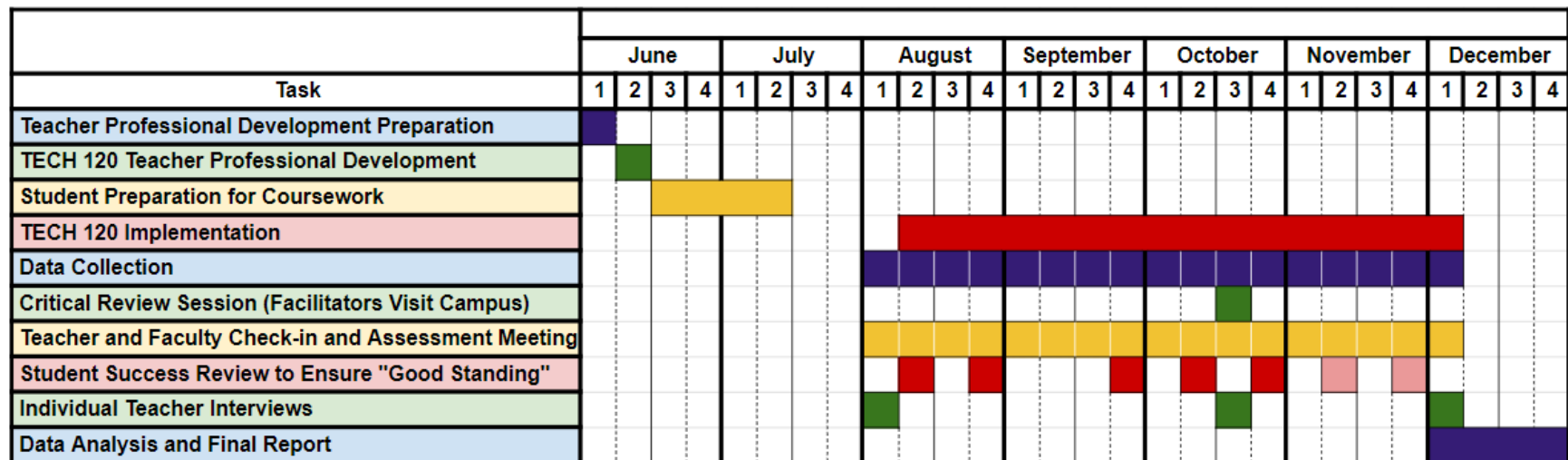


Figure 3. *Purdue's Collaborative Research Project Gantt Chart*

3.1 Purdue's Collaborative Research Project Overview

Purdue's collaborative research project was created to address the underrepresentation of low income, African American, and Hispanic students at major universities across the United States. Part of this can be attributed to lower participation in dual college credit courses while in high school, leading to underprepared students on higher stakes tests. On a local level, out of the "48,000 Indiana high school graduates in 2014 who took the SAT, only 101 African Americans and 156 Hispanics had SAT scores and GPAs in the range as the average Purdue freshmen" (Zink, 2016). This disparity becomes even more clear when looking back at comments made by Mitch Daniels, President of Purdue University from the fall of 2016. In 2016 there were 8,294 graduates from the Indianapolis Public School system (STATS Indiana, 2019), and yet only 26 met the requirements to gain admittance to Purdue University (Zink, 2016). To address this problem, Purdue University has strategically fostered relationships with urban public charter schools, located within high need areas, to create a transformed integrated STEM educational environment characterized by industry-focused and design-based learning to help prepare students for the future of work and learning. These innovative high schools boast a new approach to curriculum design, and while it provides students with industry mentors and an immersive STEM experience, it also promises preferred admission to Purdue's Polytechnic Institute.

As these innovative high school students prepare for their first year of college, the University is likewise preparing for them with various collaborative research projects with innovative high schools. Studies show that first generation college students struggle with increased expectations, change of environment, and a push towards independence versus interdependence (Coffman, 2011; Stephens et al., 2012). The collaborative research project utilized for collecting data during this study was established to increase physical, and emotional connections to campus, while providing supports for students to transition to a large university.

Purdue hosted a professional development to prepare teachers from two innovative urban public charter schools to facilitate Tech 120: Design Thinking in Technology, a required course for any student's plan of study in the Purdue Polytechnic Institute. Following the facilitator model for dual credit, a Purdue faculty member served as the instructor of record and graded key projects for directly transcribed college credit. Additionally, a Student Success Coach acted as a liaison between the university and high school and met with teachers facilitating the course weekly to provide ongoing support, instruction, and monitor the fidelity of implementation

throughout the year. Tech 120: Design Thinking in Technology is to be the first course offered through this collaborative research project.

In preparation for professional development, the Purdue research team collected data in the spring relating to the physical environment, administrators' interactions with teachers, teachers' interactions with students, and the delivery style of curriculum to help design and plan the virtual workspace for collaboration. A comparison of learning outcomes from the professional development team with information obtained from early observations helped to identify items to be used on a pre-professional development questionnaire to be used as part of the research for this thesis.

Purdue's collaborative dual credit program with an urban public chart school was piloted with fifty (50) students, from the two (2) aforementioned inner-city high schools in Indiana and involved five (5) teacher participants who acted as facilitators of the curriculum. Teacher participants consisted of both males and females with industry experience in various design fields. The number of participants, five (5), is also appropriate as this is a qualitative investigative study, in which the focus is on depth of information gathered, and it is unconcerned with justifying a hypothesis with a larger population sample. It is fortunate that all facilitators were enthusiastic and willing to participate in the study, and that the number satisfies the requirements of saturation and sufficiency needed to draw conclusions from the data (Creswell, 1998).

While the integrity of each lesson for Tech 120: Design Thinking in Technology remained unchanged, adjustments were implemented for integration to a high school curriculum. At the university level, the class meets with an instructor face-to-face approximately twenty-nine (29) times each semester, twice a week for 50 minutes. These include meetings where students are expected to complete fieldwork tasks, such as interviews and observations, instead of meeting with the instructor (Mentzer et al., 2020). The high school schedule spanned eighteen (18) weeks where students met four (4) days a week, for fifty (50) minutes each day, totaling approximately seventy-two (72) class meetings total. The researcher worked closely with course coordinators to document and implement scheduling and thematic adjustments to better align with the high school academic year, scheduled breaks, and other inconsistencies. Documentation and data collection of any course modifications was necessary to monitor implementation effectiveness throughout the academic year.

In the second week of November, student teams and facilitators virtually met with on Purdue design and innovation instructors for a review of their research and prototyping plans. During this time Purdue faculty met with the entire class and gave individual feedback to groups, reviewed progress on projects, and helped to generate solutions to questions and setbacks for both students and facilitators. Documenting and categorizing the types of questions brought forward provided valuable feedback in anticipating areas of concern for future iterations of the course.

The focus of this research is on identifying and meeting teacher needs for successful scaling for future iterations of the program. The researcher served as the Student Success Coach and maintained continued access to the teachers facilitating the curriculum both during professional development and throughout the school year. As part of the collaborative research project agreement, there is a second study running in parallel throughout Purdue's collaborative research project investigating student enrollment and college preparedness. Researchers from this project were also utilized to improve the credibility of this thesis with a triangulation of investigators approach to collected data (Merriam & Tisdell, 2015).

3.2 Qualitative Research

The majority of published research about the facilitator model focuses on higher level high school math (L. J. Pyzdrowski et al., 2006, 2011, 2016), but little evidence could be found to support its implementation in other curriculums. This research will contribute to its application in a complex project-based curriculum focused on real-world problem solving (Liedtka, 2011). Additionally, the studies that could be found about the facilitator model (L. J. Pyzdrowski et al., 2006, 2011, 2016) focused more on student outcomes, and less on the preparedness of facilitators, an important component of this style of dual credit coursework.

The two questions driving this research are:

1. In what ways did this one week-long professional development prepare teachers to teach a facilitator model dual credit course?
2. In what ways does ongoing support throughout the academic year meet teacher needs?

A qualitative study is most appropriate when addressing these research questions as the main goal is to gain a greater understanding of the perspective of the teacher facilitators (Mills & Gay, 2019). To accomplish this, a great deal of time was spent gathering data directly from each participant in the form of observations, interviews, and collected artifacts. The researcher also approached this project without assumptions, relying on a triangulation of methods to discover and understand necessary support structures. In addition, qualitative studies have advantages in evaluating professional development in education (Robinson, 2019; Yurtseven & Bademcioglu, 2016), as they are able to provide more detail and context with regard to outcomes.

3.3 Case Study

A ‘theory seeking’ case study was chosen for this qualitative framework as it is a goal to find generalizations and convey them to a broader audience (Bassey, 1999). The research questions lend themselves well to an investigative approach, and working with a small sample size from a school recognized for its innovative and unique approach to education creates natural boundaries (Bassey, 1999; Creswell, 1998). While the professional development took place virtually, the course implementation took place within its normal context, providing evidence to inform future iterations of the program to policymakers (Bassey, 1999). Through interviews, observations, questionnaires, and artifacts, data was collected and coded such that plausible and trustworthy conclusions may be drawn, and an audit trail created for confirmability (Bassey, 1999; Merriam & Tisdell, 2015).

3.4 Sample

This study consists of group of five (5) white, mid-western teachers representing an age range of thirty (30) to sixty (60) years old, representing all facilitators in this collaborative research program. While there was a mixture of males and females serving as teacher facilitators, this ratio is not addressed to preserve anonymity of participants. Due to the school’s approach to curriculum, many teachers and students have entry skills in problem solving and human-centered design. While all teachers serve in the same role at these innovative urban public carter schools, there is no overlap in previous teaching or job experience. A learner analysis (Dick et al., 2015)

was created from data obtained from both a pre-professional development questionnaire, and interactions with teachers during professional development (see Table 2).

Table 2

Learner Analysis

Information Categories	Data Sources	Learner Characteristics
Entry Skills	Questionnaire	All teachers have experience in teaching problem solving skills using a human-centered design approach
Prior Knowledge	Questionnaire	All teachers come from different content backgrounds with specializations in prototyping, project planning, and problem solving
Attitudes Toward Content	Questionnaire	There is a general curiosity in how different the design thinking approach and what the curriculum for such a course looks like
Attitudes Toward PD Delivery System	Questionnaire and Personal Interactions	Even though the professional development is being held online, there teachers convey an enthusiastic attitude
Motivation for Participation	Questionnaire and Personal Interactions	While selected by their administrators, all express genuine enthusiasm for providing dual credit opportunities for their students
General Learning Preferences	Questionnaire and Personal Interactions	All seem to indicate a preference for hands-on learning, as is also reflected in their roles at each high school
Attitudes Toward Purdue Professional Development	Questionnaire and Personal Interactions	Teachers have expressed eagerness to increase collaboration with Purdue University
General Group Characteristics	Questionnaire and Personal Interactions	Group has a variety of teaching styles with a commonality being a good rapport with students

3.5 Preparation for Data Sampling

A performance context analysis was also created using information from the pre-professional development questionnaire and interviews throughout the workshop to review administrative support, physical aspects of the schools, and social aspects of the schools (see Table 3) (Dick et al., 2015). Utilization of this tool is anticipated to be advantageous as Tech 120: Design Thinking in Technology relies heavily on prototyping and design. Being able to identify what materials, tools, equipment, and physical space is available to each teacher, ongoing support throughout the year can be more effective and personalized. Likewise, an understanding of the social aspects of the site can lend greater insight to both teacher collaboration and student group work.

Table 3*Performance Context Analysis*

Information Categories	Data Sources	Performance Site Characteristics
Managerial/Supervisory Support	Questionnaire	The administrator is active and involved with multiple facets of the school and is very supportive of Purdue's collaborative research program.
Physical Aspects of Site		
High School A	Interviews	Teachers are unsure about classes for the fall as they will be changing building locations. Noted that there are no bells to dismiss class.
High School B	No Data	
Virtual Aspects of Site		
High School A	Interviews	Teachers are using Google Meet to hold classes. Students are able to see other classmates, and answer questions with their microphones or by typing. Online collaboration tools such as 'Jamboard' were used to simulate group work.
High School B	Interviews	Teachers use a combination of Zoom and Google Meet to hold classes. Zoom offers the additional benefit of assigning 'rooms' for groups to meet. The teacher has the ability to send messages to all the rooms at once, notifying when to come back to the main group chat. 'Jamboard' has also been used for online collaboration.
Social Aspects of Site		
High School A	Questionnaire	Students engage in both group and individual work. Teacher gives brief introduction before letting them work for the day.
High School B	Questionnaire	Level of engagement varies with style of teaching. Students had established rapport of working together and continued to do so even though the class was online.

Lastly a learning context analysis was conducted on the online professional development environment that the teachers utilized for summer collaboration. This consists of an analysis of various curricular requirements, accessibility to various features of the learning management system, adaptability of activities to simulate the facilitator’s daily teaching environment, and any virtual constraints that may impact design and delivery (See Table 4) (Dick et al., 2015).

Table 4

Learning Context Analysis

Information Categories	Data Sources	Learning Site Characteristics
Nature of Site	Personal Communication with Professional Development Instructor	<p>Microsoft Teams online collaboration workspace.</p> <p>G-suite tools such as docs, sheets, and slides.</p> <p>Other collaboration tools including digital white boards.</p> <p>Brightspace, Purdue’s Learning Management System.</p>
Site Compatibility with Teacher Needs	Personal Communication with Professional Development Instructor	Teachers have dedicated spaces for large and small group discussion, a means of brainstorming, and a way to submit work for feedback.
Site Compatibility with Researcher Needs	Personal Communication with Professional Development Instructor	Microsoft Teams allows for recording of large and small group discussions. All professional development artifacts can be collected from the submissions through Brightspace or Teams.
Feasibility for Simulating School Environment	Personal Communication with Professional Development Instructor	Students in the fall will utilize both Brightspace and Microsoft Teams for communication with the Student Success Coach.

3.6 Instrumentation

Several instruments have been identified to help construct effective questionnaires to be used with teacher facilitators before and after professional development, as well as before and after course implementation. While using quantitative tools in qualitative research may not be typical, there are several advantages it provides for this specific case study. Due to the professional development being condensed to just four days and having limited access to teachers throughout the school year, it is advantageous to take advantage of pieces of these instruments to narrow the focus of interviews and ask informed and relevant questions. Even though these instruments utilize Likert scales resulting in quantifiable data, modifications were made to instead collect qualitative open response information. This information was used to help structure and guide focus group and individual interviews throughout the professional development and course implementation process. These instruments, obtained from the Stelar STEM Learning and Research Center, consist of DET Instrument to Evaluate Design Thinking (Appendix F) (Yaşar et al., 2006), Wilder Collaboration instrument (Appendix G) (Amherst H. Wilder Foundation, 2018), RTOP Observation Instrument (Reformed Teaching Observation Protocol) (Appendix H) (Sawada et al., 2000), and the Project Specific Questions (Appendix I) (Researcher, 2020).

Due to the nature of Tech 120: Design Thinking in Technology, the pilot course of the Purdue's collaborative research program, the DET Instrument to Evaluate Design Thinking (Appendix F) (Yaşar et al., 2006) was chosen as a way to gauge individual content knowledge. This helps to address the research question of 'How and in what ways did this one week-long professional development prepare teachers to teach a facilitator model dual credit course?' as it identifies prior knowledge and entry skills of participants and narrows the focus to new information.

Purdue's collaborative research program identified that though the innovative urban public carter school campuses are physically close, and share the same ideology and curriculum structure, the two schools do not often collaborate. The Wilder Collaboration instrument (Appendix G) (Amherst H. Wilder Foundation, 2018) was chosen as a measure of willingness for schools to both collaborate with each other and with Purdue University faculty. Although the most valuable insights were derived from collaboration with Purdue University faculty, as this is a necessity for the facilitator model, creating a network of teachers for a shared curriculum may

have positive impacts on long-term sustainability of the program. This addresses the second research question ‘How and in what ways does ongoing support throughout the academic year meet teacher needs in a design-based, facilitator model dual credit course?’

The results from these surveys were used to drive interviews, check assumptions made in observations, and identify what behaviors were most important to observe during professional development. Key items from the RTOP Observation Instrument (Reformed Teaching Observation Protocol) (See Appendix H) (Sawada et al., 2000), also from the Stelar STEM Learning and Research Center, were utilized to aid in consistency of observations throughout the professional development and course implementation. Because the instruments were not designed for this project, questionnaires were supplemented with Project Specific Questions (Appendix I) (Researcher, 2020).

3.7 Professional Development

While the creation of the professional development experience lies outside the boundaries of this research, it was important to consider the aforementioned needs assessments in evaluating the ways in which both the professional development and ongoing support meet the needs of teachers as facilitators of Tech 120: Design Thinking in Technology curriculum. The data collection strategy (see Figure 4) took place throughout the week-long professional development process.

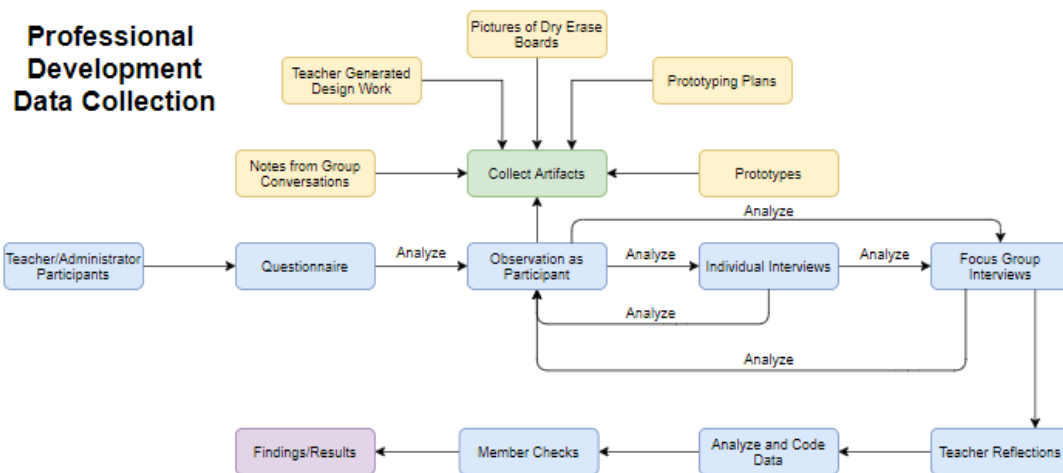


Figure 4. *Professional Development Data Collection*

3.7.1 Recruiting Teacher Facilitators

Leading up to the professional development, site visits were conducted with Purdue's collaborative research program team to develop meaningful professional development. Due to unforeseen circumstances from Covid-19, only one of these site visits was made in person while other classroom observations took place through Google Meet and Zoom. For the same reasons the summer professional development was held online as well.

Administrators were provided with a Letter of Cooperation (see Figure 5) as both a means of informing them with details of our intention to use data obtained through Purdue's collaborative research program in a research capacity, and to acknowledge and grant permission to do so. Forms were signed and returned to the research team.



Date: 4/26/2020

Re: Letter of Cooperation from

Dear **Dr. Nathan Mentzer**,

This letter confirms that I, as an authorized representative of the _____, allow your research team (**Dr. Nathan Mentzer, Dr. Greg Strimel, Dr. David Sears, and Mr. Scott Thorne**) access to conduct study related activities throughout the implementation of the TECH 12000 course, as discussed with the Principal Investigator and briefly outlined below, and which may commence when the Principal Investigator provides documentation of IRB approval for the proposed project.

- **Study Title:** *HS Facilitator Model 2020 Teacher Development*
- **Study Activities Occurring at this Site:** *The research team will conduct observations and collect teacher generated artifacts (notes from group interactions, design documentation, and prototypes) during the TECH 12000 professional development. Also, the team will conduct observations while the teachers deliver their TECH 12000 lessons in their classrooms as well as carry out interviews, both individual and group, throughout the research period. Lastly, questionnaires will be distributed to the teachers at the beginning and end of the professional development as well as at the beginning and end of the semester. The research team hopes that these data will aid in discovering key needs, and supports to meet these needs, to best prepare teachers to provide dual credit pathways.*
- **Site Support:** *High Schools will provide connections with the teachers for data collection and support teacher participation in the dual credit program.*
- **Other:** *After the study is complete, the research team will present a summary of the results to relevant High School stakeholders, following the appropriate protocol to protect the confidentiality of the participants.*
- **Anticipated End Date:** *3/31/2021*

I understand that any activities involving compliance with Health Insurance Portability and Accountability Act (HIPAA), Family Educational Rights and Privacy Act (FERPA), or other applicable regulations at this site must be addressed prior to granting permission to the Purdue University researcher to collect or receive data from the site. I am authorized to make this determination on my organization's behalf.

We understand that _____ participation will only take place during the study's active IRB approval period. All study related activities must cease if IRB approval expires or is suspended. If we have any concerns related to this project, we will contact the Principal Investigator who can provide the information about the IRB approval. For concerns regarding IRB policy or human subject welfare, we may also contact the Purdue University IRB at irb@purdue.edu (www.irb.purdue.edu).

Figure 5. *Letter of Cooperation*

While teachers are already aware of the role of research in the project, a formal presentation of the depth of research, rights as participants, and length of study was presented at the start of the professional development in June. Research participant consent forms were distributed before professional development began (Appendix K) (see Figure 6), and returned digitally on or before the first day of collaboration.

RESEARCH PARTICIPANT CONSENT FORM - INSTRUCTOR

Dr. Nathan Mentzer
Technology Leadership and Innovation
Purdue University

Key Information
Please take time to review this information carefully. This is a research study. Your participation in this study is voluntary which means that you may choose not to participate at any time without penalty or loss of benefits to which you are otherwise entitled. You may ask questions to the researchers about the study whenever you would like. If you decide to take part in the study, you will be asked to sign this form, be sure you understand what you will do and any possible risks or benefits. You will be prepared to facilitate the curriculum for Purdue's Tech 120 - Design Thinking in Technology course, and this study will help researchers investigate dual credit models for direct credit transfer. The duration of this study is one academic year. Potential risks are no greater than normal classroom activities but could include a breach of confidentiality. Potential benefits may include improvement in student learning, motivation and self-efficacy while also allowing students to earn direct college credit through Purdue University.

What is the purpose of this study?
College access remains a priority for Indiana, specifically for minoritized urban youth. While it seems as though is well on its way to prepare more students for the future of learning and work, Purdue may not be positioned to yield students who might qualify for admissions to Purdue and have interest in pursuing higher education. By establishing the Purdue program, students will (1) be supported in the transition to a large university while they are in high school with their everyday teachers, (2) be provided with a true connection to the university, (3) make progress toward a degree by earning direct credit, (4) gain experiences that directly relate to college life at a large institution, and (5) likely, according to research, perform better on campus. Another benefit of this program is the high-potential for scalability to other schools throughout the state to support program sustainability. By participating in this research, we will gain a better understanding of how to support dual credit programs and scale up to include other schools after the study. We anticipate enrolling 10 teachers.

What will I do if I choose to be in this study?
During the professional development and implementation of the Tech120 course, we seek to collect data on teacher experiences, teacher learning, and implementation reflection. To gather these data, we will:
1. Conduct individual and group interviews about design thinking, collaboration and professional development experiences.
2. Conduct surveys about design thinking, collaboration and professional development experiences.
3. Conduct observations of the teacher during the professional development and while facilitating the course.
4. Collect teacher design work artifacts such as design journals, notes, prototypes.
5. Collect teacher lesson plans including how Tech120 is adapted to fit the school structure.
6. Collect teacher evaluation of deidentified student work.

How long will I be in the study?
This is a one-year engagement with the school.

What are the possible risks or discomforts?
No risks greater than those experienced in ordinary classroom learning and teaching environments are anticipated.

Are there any potential benefits?
This program has a high-potential for scalability to other schools throughout the state to support program sustainability and expand on mission to develop a new generation of skilled talent by seamlessly transitioning students from high school to college to high-tech and/or high-wage jobs. Also, this program can help facilitate College of Education preservice teacher placements in schools, thereby offering a pathway for Purdue students to future careers at . During the conversations with researchers and colleague teachers, you will have the opportunity of hearing from other instructors about their teaching strategies, plans, and experiences. You may also have the chance to share your own experiences. Your participation may benefit you, other instructors, and future instructors of these courses. Your experience could also aid future students by offering more opportunities for obtaining college credits.

Will I receive payment or other incentive?
No.

Will information about me and my participation be kept confidential?
No names or identifying information will be archived from our observations or interactions. Data will be kept on password-protected computers. Audio recordings will be stored on a hard drive shared by the research team. Video recordings will be deidentified using facial blur technology. Data will be kept for 5 years after the project is complete. Only the research team will have access to the data for analysis purposes. The project's anonymized research records may be reviewed by departments at Purdue University responsible for regulatory and research oversight.

What are my rights if I take part in this study?
Your participation in this study is voluntary. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled. Your position and evaluation as an instructor will not be affected by whether or not you participate in this study. If you withdraw prior to the end of the study, any materials provided by the research team must be returned.

Who can I contact if I have questions about the study?
If you have questions, comments or concerns about this research project, you can talk to one of the researchers. Please contact Dr. Nathan Mentzer, nmentzer@purdue.edu, 765.494.0298.
If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Human Research Protection Program at (765) 494-5942, email (hrb@purdue.edu) or write to: Human Research Protection Program - Purdue University
Ernest C. Young Hall, Room 1032
155 S. Grant St.
West Lafayette, IN 47907-2114

Documentation of Informed Consent
I have had the opportunity to read this consent form and have the research study explained. I have had the opportunity to ask questions about the research study, and my questions have been answered. I am prepared to participate in the research study described above. I will be offered a copy of this consent form after I sign it.

Participant's Signature	Date
Participant's Name	
Researcher's Signature	Date

Figure 6. Research Participant Consent Form

The researchers also used a script to introduce themselves, their role in the research, intended outcomes, and rights of participants on the first day of professional development (Appendix L) (see Figure 7).

Teacher recruitment script (shared at professional development):

We are conducting research to evaluate and improve the professional development and dual credit implementation of Tech120. We need the help of teachers who are involved with the Purdue Project to provide insight into their experiences.

During the professional development and implementation of the Tech120 course, we seek to collect data on teacher experiences, teacher learning and implementation reflection. To gather these data, we will:

1. Conduct individual and focus group interviews with teachers about design thinking, collaboration and professional development experiences.
2. Survey teachers about design thinking, collaboration and professional development experiences.
3. Conduct observations of teachers during the professional development and while teaching in their classrooms.
4. Collect teacher design work artifacts such as design journals, notes, prototypes.
5. Collect teacher lesson plans including how Tech120 is adapted to fit the school structure.
6. Collect teacher evaluation of deidentified student work.

Your participation is voluntary and you may choose to stop at any time. Your participation may lead to improvements in the program. If you would like to participate or would like more information please contact me (Nathan Mentzer) via email at nmentzer@purdue.edu.

At this time, I'd like to pass out the Consent form and discuss it with you. If you are interested in participating in the research, please sign the consent document and return it to me.

Thank you!

Figure 7. Teacher Recruitment Script

3.7.2 Professional Development Data Collection

Summer professional development took place over the course of four consecutive, seven-hour days in an online learning environment. During this time teachers were introduced to panels of both students and faculty, presented with exemplar artifacts of learning outcomes, and engaged in experiential learning from selected, pre-determined lessons from the research team. Six lessons were selected as a representation of the core learning outcomes for Tech 120: Design

Thinking in Technology. A model lesson was presented from one of the researchers on the first day, engaging all teachers as students, while subsequent lessons were assigned such that each teacher had the opportunity to fulfill an instructor role. When it was not time to act as instructor, teachers served in a student role both actively participating in class activities and generating summative assessments for later review (see Figure 8).

	Monday	Tuesday	Wednesday	Thursday	
	June 8 - Project 1	June 9 - POV	June 10 - Interviews/Observations/ Literature	June 11 - Prototyping	
8:30	Design Introduction	Orientation Dialogue KWL	Orientation Dialogue KWL	Orientation Dialogue KWL	
9:00	Welcome and Overview of the Course Venn diagram	Guest Talk (Faculty Panel)	Guest Talk (Recruitment Panel)	Discussion: Assignment submission as a student Assignment grading / feedback as a teacher	
9:30	Design and Innovation Competition	Research Details for Fall	Teacher: Model a lesson M6, M7 - A day in the life of Tech120 class meeting		Design Journal Review Final Project Grading Rubrics
10:00					
10:30	Teaching Assignments	Timeline of critical University Add/Drop enrollment events		Venn diagram - between Tech120	
11:00		Individual working lunch			
11:30	Individual working lunch		Individual working lunch	Collaborative working lunch - Discussion - Implementation - Academic Year Support	
12:00					
12:30	Facilitator: Model a lesson M4 (Design Critique) - A day in the life of Tech120 class meeting	Guest Talk (Tech120 Alum Panel)	Teacher: Model a lesson M8 - A day in the life of Tech120 class meeting	Dissertation on Lived Challenges of Black Females in STEM Fields	
1:00		Teacher: Model a lesson M3 (POV) - A day in the life of Tech120 class meeting	Teacher: Model a lesson M10 (ideation) - A day in the life of Tech120 class meeting		Teacher Led Collaborative Planning
1:30					
2:00		Q&A (Prep)	CATME - Measure of "team member effectiveness"- Overview and Experience	Facilitator: Lesson discussion M20, 21, 24, 25 (Prototyping)	
2:30					
3:00	Focus Group / Reflection	Interview - Researcher A Structured Prep - Researcher B	Prep for grading - submit and grade Interview - Researcher A Structured Prep - Researcher B	Interview - Researcher A Structured Prep - Researcher B	
3:30					
After hours	Reading/Video - Prep	8:00 Virtual Happy Hour	Fall implementation prep/Prototyping		

Figure 8. Summer Professional Development Schedule

Observation played a critical role in the analysis of needs during professional development, as multiple hours of collaboration were captured each day. This was aided by the fact that the course happened online in the Microsoft Teams environment, where the group of high school teachers had the ability to record themselves individually, in small groups, or in large group sessions with the professional development coordinators. Teachers were aware of the recordings, and anonymity was preserved with audio preserving transcription software, allowing reactions, intonations, and surrounding context to be captured and preserved.

While there are many strategies for observations, the theoretical framework of how and in what ways is it preparing teachers to teach a facilitator model of a dual credit course was a guiding factor on the lens through which their actions are interpreted (J. A. Maxwell, 1996; Merriam & Tisdell, 2015). The design of the Tech 120: Design Thinking in Technology professional development involved teachers playing an active role in completing a project using the design thinking steps. Informed by the RTOP Observation Instrument (Reformed Teaching Observation Protocol) (See Appendix H) (Sawada et al., 2000), also from the Stelar STEM Learning and Research Center, observations were made, and artifacts collected on several key stages of the process, including: notes from conversations, teacher generated design work, pictures of digital dry erase boards, prototyping plans, and final prototypes. After each stage of observation, the researcher conducted either individual or focus group interviews, using the responses from the interview to influence what kinds of observations were made for the next phase of the research project.

Similar to a student experience, teachers had both individual and group tasks in completing their design project. Submissions were made in the form of PDFs through Brightspace, Purdue's Learning Management System. Submissions, rubrics, and feedback to participants was recorded and documented for further analysis. Names were removed and replaced with pseudonyms to de-identify this information.

A number of online tools were used for distance collaboration, including the use of a digital dry erase board. Group tasks requiring the creation of sketches, Venn diagrams, and brainstorming utilized this tool, and results were documented through screen capturing software such as Microsoft Snip & Sketch. As information collected at this stage was already anonymous, no further de-identification was required.

Though typically reserved for short, one-visit interviews, the researcher took on the role of 'Observer as participant' (Gold, 1958), serving in the primary role as observer, while still participating to some extent while working with small groups of teachers. Even though an extended amount of time was spent working with the teachers, the delivery was online and the researcher's time was split across five (5) different teachers.

Post-professional development interviews were semi-structured, and contained approximately six (6) open-ended questions focused on behaviors observed during professional development, as well as items of interest that were not observed that the researcher wished to

Course implementation consisted of the first week of August (see Figure 10), and weekly teacher facilitator and faculty check-in meetings took place until the third week of December. Meetings lasted approximately one (1) hour, and while part of the meetings were utilized to support Purdue's collaborative research project, informal focus group interviews were also conducted during this time. The first set of interviews utilized questions driven from responses to the pre-course implementation questionnaire as well as items from the DET Instrument to Evaluate Design Thinking (Appendix F) (Yaşar et al., 2006), and the Project Specific Questions (Appendix I) (Researcher, 2020).

In addition, in order to better understand the level and type of ongoing support throughout the school year, time was scheduled for individual interviews with each facilitator at the beginning, middle and end of the course. These interviews took place during the first (1st), eleventh (11th), and seventeenth (17th) weekly meetings. While the significance of the first and last weeks of course implementation may be apparent, the eleventh (11th) week was chosen as it is both midway through course implementation, and the week before a major cut-off date in which the university will no longer allow for students to withdraw from the course. The researcher led the facilitators in weekly curriculum update meetings and use information gathered from this to better answer the research question 'How and in what ways does ongoing support throughout the academic year meet teacher needs in a design-based, facilitator model dual credit course?' Individual interviews often took place in the same week as weekly curriculum meetings, but were rarely scheduled on the same day to prevent participant fatigue.

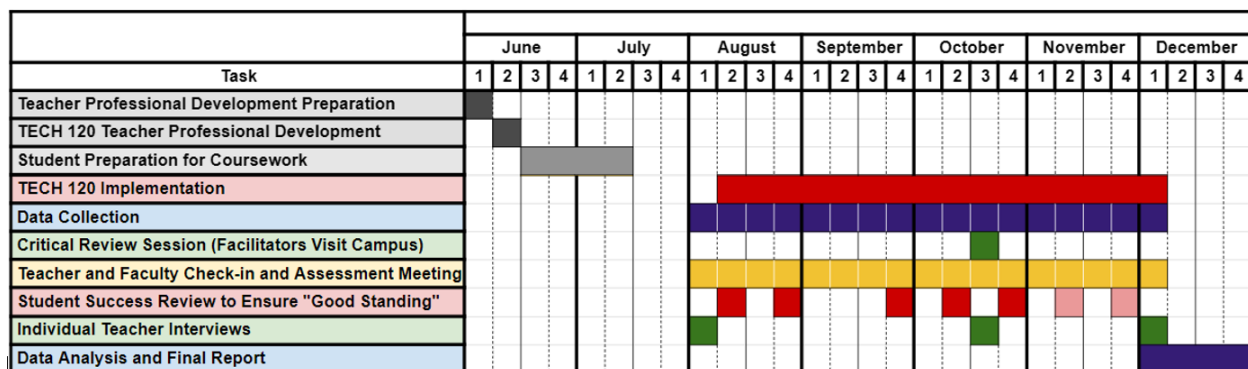


Figure 10. *Course Implementation Gantt Chart*

From August through December, the researcher also acted as the ‘Student Success Coach’ to students enrolled in Purdue’s collaborative research program. The researcher provided course information and respond to questions through email, and at times virtually attended classes for question and answer sessions when requested by facilitators. These interactions with students helped to identify further areas of need or support, as the way in which curriculum is delivered can have as much of an impact as the content of what is delivered (Little et al., 2009).

Throughout the month of November facilitators were in the final stages of projects, grades, and working closely with the university Student Success Coach to ensure that students who earned credits had a proper transcript at the end of the semester. While questions posed at the beginning of the semester served as an indicator of where teachers may feel they need more help and support after summer training, questions during this time in the year will further identify “In what ways did ongoing support throughout the academic year meet teacher needs?”

Items for the questionnaire were sampled from the DET Instrument to Evaluate Design Thinking (Appendix F) (Yaşar et al., 2006), Evaluating Professional Development Instrument (Appendix E) (Guskey, 2002), and the Project Specific Questions (Appendix I) (Researcher, 2020). Microsoft Teams was used to conduct and record interviews with participants in order to transcribe any individual interviews or focus group meetings, and to allow the researcher to review and re-analyze responses (Creswell, 1998; Sekaran & Bougie, 2016).

After the post-course implementation questionnaires were analyzed the teacher facilitators will participated in a semi-structured interview on their experience facilitating Tech 120: Design Thinking in Technology. Special interest was placed on questions pertaining to the successes and challenges related to the three unique aspects of the facilitator model: the facilitating teacher, the Student Success Coach, and the instructor of record. These data not only address the research questions driving this study, but aid in making predictions of challenges and successes if the program were to be offered to a wider range of schools or provide more course opportunities.

3.9 Data Analysis

This study generated a great deal of data (see Figure 11), requiring the use of a software and other online programs for organization and long-term retention. The researcher utilized a combination of otter.io, an auto-transcription website, and NVivo, a software program capable of sorting audio and video clips, images, and other artifacts.

40 hours summer professional development
30 hours weekly meetings
5 hours PD interviews
5 hours beginning semester interviews
5 hours mid semester interviews
5 hours final semester interviews
1 hour student interviews
91 hours of transcriptions

Figure 11. *Transcribed Data from this Study*

Recordings were created using Microsoft Teams software, the videos were then downloaded to the researcher's computer before being re-uploaded to the otter.io website. Otter.io preserves the audio from the video, automatically separates different voices, and includes timestamps of the entire conversation. Pseudonyms were assigned to each speaker, and the transcription was proofread and edited for accuracy. Once satisfactory, the transcription was exported as a .docx file including speaker names, timestamps, and highlights. The document was again opened in Microsoft word, and the 'Find and Replace' function was used to detect, identify, and replace any names that may have been missed with pseudonyms. This document was then uploaded to NVivo, where the transcription was read through again, this time to identify themes. The Perceived Need Flowchart (Appendix D) was utilized in creating initial nodes, while other nodes were created as themes emerged.

Merriam and Tisdell (2016) stress starting the data analysis as soon as you have data, as qualitative studies can become overwhelming. As previously noted, during professional development teachers recorded themselves individually, in small groups, and as a large group, compounding the data that needed to be sorted and coded. When it comes to the actual analysis, a six (6) step axial coding technique is suggested to organizing and coding data: stay focused on the research questions, consider the framework used in for the study, use terminology and codes related to the research questions, re-code into broader categories, check that the broader categories are appropriate for individual codes, and continue to create broader categories that encompass greater portions of the data (Merriam & Tisdell, 2015).

In theory this is comparable to the code-recode procedure (see Figure 10) (Poggenpoel & Myburgh, 2003; Saldaña, 2013) where data are arranged into codes and subcodes, categories and subcategories, until categories get so broad that themes, concepts, assertions, and theories begin to emerge. As case studies tend to be rich in data, either model is appropriate for this study, and both were used to compare results. The professional development portion of this study generated a large amount of data in a short amount of time and was coded using the axial coding technique. Course implementation also generated a large portion of data, but did so over a much longer period of time, allowing for more thought to be put into the code-recode technique to generate assertions and make implications about the findings.

After themes were identified, member checks were performed with teacher facilitators as a measure of dependability, while also being checked with other researchers as a means of triangulation.

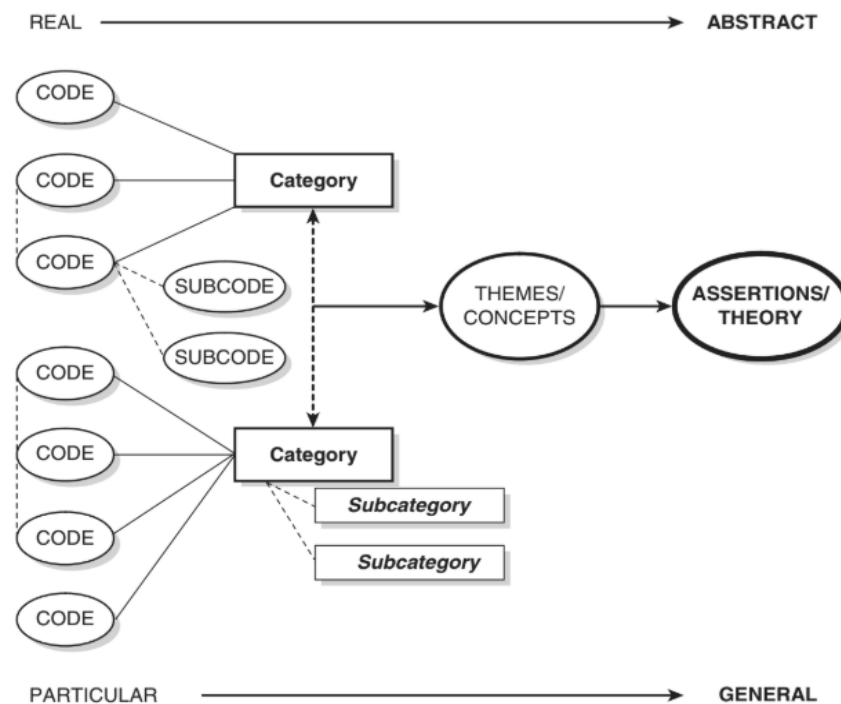
3.10 Role of the Researcher

It is the case with qualitative studies that in addition to interpreting the data, the researcher becomes the instrument for collecting it as well (Poggenpoel & Myburgh, 2003). As the key individual making observations, conducting interviews, and leading focus group discussions, it is possible that the role of the researcher may affect the outcome of the study. It is therefore imperative that measures be taken to increase trustworthiness of data collected and coded as part of the study through credibility, transferability, dependability, and confirmability (Creswell, 1998; Merriam & Tisdell, 2015; Poggenpoel & Myburgh, 2003).

3.11 Trustworthiness and Credibility

To address the trustworthiness and credibility of findings, it is important to note that the sample consists of the entire population of teachers as facilitators of the curriculum. To confirm that findings are reported accurately, the researcher conducted a number of member checks on conclusions drawn from the data. Interviews were transcribed and analyzed in depth addressing the issue of dependability by utilizing a code-recode procedure (see Figure 12) (Poggenpoel & Myburgh, 2003; Saldaña, 2013). Observations were conducted using the RTOP instrument (Reformed Teaching Observation Protocol) (See Appendix H) (Sawada et al., 2000) and

transcribed using thick rich description for depth of detail to enhance transferability (Poggenpoel & Myburgh, 2003). A significant amount of time was spent in the field, and both a triangulation of methods using literature, observations and interviews, and triangulation of researchers using researchers in a parallel study focused on student outcomes were used to enhance credibility (Merriam & Tisdell, 2015). To elevate confirmability, conversations were recorded to capture audio and/or video before being transcribed to create an audit trail, while using face blurring software and pseudonyms to preserve anonymity.



Note. Reprinted with permission from *The Coding Manual for Qualitative Researchers*, by Saldaña, 2013, p.13.

Figure 12. *Code to Theory Model for Qualitative Inquiry*

To address transferability, notes are highly detailed, including descriptions of the activities, comments from participants, and comments from the researcher (Creswell, 1998; Malu, 2015; Merriam & Tisdell, 2015). By keeping detailed notes about how each teacher interacts with their surroundings and with each other, correlations may be made about what they are doing well and how they are applying content to context. Likewise, if some teachers appear to be holding back, or missing cues from others, it may demonstrate a poor understanding of content, signaling a need for reclarification. Documenting these assumptions allow for the

creation of questions in interviews and focus groups. From a professional development team standpoint, knowing what is working in professional development is just as important as what is not working so that refinements can be made for future iterations.

To ensure credibility, these observations were followed by individual interviews as a means to ‘member check’ assumptions and findings (J. A. Maxwell, 1996; Merriam & Tisdell, 2015). Having member checks as an ongoing process throughout the professional development increases the credibility of the study as assumptions are refined and confirmed at the end of the process.

3.12 Researcher Bias

As an educator of a dual enrollment course for ten (10) years, the researcher comes into the study with inherent assumptions and biases. This background knowledge provided a unique insight into the reactions experienced in collaborating with universities and students in the dual credit process, but the researcher was also at risk of projecting individual feelings onto that of the data. To account for these, the researcher conferred with other investigators when preparing for semi-structured interviews, and member checked themes and findings from data.

The researcher also served as the Student Success Coach, and as such provided weekly support to facilitating teachers as well as feedback and grades to students involved in the course. While documented in the paperwork, additional steps were made to remind teachers that their support was not contingent on their participation in the study, and their comments, interviews, and artifacts will be kept anonymous.

3.13 Summary

The research methodology section has introduced the role that Purdue’s collaborative research project plays in this study, the reasons for a qualitative approach, and the logic behind using a case study. The sample population of teachers was introduced and analyzed using a learner analysis chart, while also examining their classroom teaching environment using a performance context analysis, both driven by firsthand knowledge from on-site and virtual observations. A learning context analysis was performed on the platform intended to deliver

professional development to lend credibility to the tools and tasks expected of teacher participants.

Consent forms from all administrators and research participants were obtained and submitted to the IRB. Data collection from both the professional development and the course implementation have been properly de-identified. Two models for analyzing and organizing data as a result of data collection were presented with rationale as to when and why to use each one.

Lastly, the researcher addressed the ways in which credibility, transferability, dependability, and confirmability may be built into the study. There are unintended biases in the study that have both been acknowledged and presented with strategies to reduce the amount of bias and increase dependability.

CHAPTER 4. RESULTS

This chapter presents qualitative findings of a facilitator model implementation of the Purdue University course Tech 120: Design Thinking in Technology. The results presented in this chapter are guided by the following research questions:

1. How and in what ways did this one week-long professional development prepare teachers to teach a facilitator model dual credit course?
2. How and in what ways does ongoing support throughout the academic year meet teacher needs in a design-based, facilitator model dual credit course?

It is for this reason that there is a differentiation in data collected from the week-long summer professional development program, and ongoing support throughout the first semester pilot across two high schools and five teachers. These two sets of data, professional development and ongoing support, will be broken into two sections with focus on four repeated main themes: aligning with Purdue, identifying barriers, ongoing support, and professional development.

4.1 Purpose of the Study

The purpose of this study is to identify supports needed for professional development, successful implementation, ongoing support, and scale-up measures of a facilitator model using Purdue's collaborative research program. Data presented is gathered from the piloting of Tech 120: Design Thinking in Technology through interviews, observations, questionnaires, and artifacts.

4.2 Summer Training Program

Summer professional development took place over the course of four consecutive, seven-hour days in an online learning environment. During this time, four (4) main themes emerged - aligning with Purdue, identifying barriers, planning for ongoing support, and professional development. Themes are defined as accounts made by participants through interviews and observations that the researcher found relevant to the study and are limited to interactions the researcher could directly observe. These four (4) themes were further derived into multiple subthemes.

4.2.1 Professional Development – Aligning with Purdue

Throughout the week-long professional development, one reoccurring theme revolved around alignment with Purdue, the cooperating university for dual credit. Subcategories for this theme include access to university resources, curriculum standards, dual credit requirements, and registering students.

Access to University Resources

To best prepare teachers to facilitate Tech 120: Design Thinking in Technology with fidelity, steps were taken to grant access to both the student and instructor side of the learning management system (LMS). This included creating instructor accounts for each teacher facilitator, as well as demo student accounts in the LMS to have a ‘true’ student view of submitting assignments, navigating curriculum, and receiving feedback. As instructors, privileges within the LMS were expanded to allow for the creation of announcements, modifications of assignments, and evaluation of student work. These accounts were created to orient teachers with Purdue’s online interfaces and proved an invaluable resource throughout the week through experiential learning scenarios.

With respect to access to necessary programs, we found that our current curriculum relies on multiple software programs and a university specific learning management system (LMS). These include Brightspace LMS, Purdue account with two-factor authentication, Google documents, CATME peer evaluation software, and Jamboard - a collaborative whiteboard. In addition, due to the Covid-19 pandemic, the professional development was hosted in an online environment facilitated with Microsoft Teams conferencing software. While setup instructions were sent to participants in advance, multiple teachers discovered after starting the workshop that they had not fully set up their Purdue accounts, limiting access to various parts of the LMS and Teams software functionality. Extra steps were taken to introduce the LMS software to teachers both as an instructor and as a student by creating demo student accounts. While this allowed a ‘true’ student view for submitting assignments and receiving feedback, it added an extra layer of complexity as teachers were tasked with managing multiple usernames, passwords, and internet browsers to use both simultaneously.

Curriculum Standards

Teacher participants were given multiple opportunities to both experience and actively reflect on the curriculum standards for aligning expectations of student outcomes. Throughout the week, teachers reflected on similarities, one teacher mentioned:

I've done an activity very similar with some of our newest students use a very similar sort of template. I think we asked the question, find some way to improve their morning routine, something along those lines. So yeah, we've done some similar stuff.

Related to fidelity of implementation, teachers asked questions such as: "I just wasn't sure, like, how to the script we had to stay", and made questions on teacher autonomy:

One of our like cardinal rules was you never asked somebody one question. You ask them two or three, and then you let them answer all of them. So in a situation like this, like, would it have been fair to say, have one or two questions or like two or three questions as question number one?

The project leaders clarified that because teachers would have more time with students, there would be time for scaffolding:

At the college level we are just meeting two hours a week, we really move pretty fast. At the high school level, you have a little more time to scaffold the students into those experiences. So that may allow for a better explanation there.

Further, the project team leaders shared with the teachers that assignment timelines and assignment expectations could be modified as long as it aligned with course goals and learning outcomes:

I think we can have some level of have flexibility in that if, let's say, I'm just going to make something up, let's say week three with POV statements, you don't do anything like that at the high school. And that part takes a little longer than a week at the high school level. But something that happened maybe in week two or say week one, with that alarm clock design problem or the design problem, we posed you with that one-hour challenge. Maybe you start with that in ninth grade, the students have been doing that cycle for two years now. There's no reason to repeat that piece... so you spend a little less time there and a little more time on the POV. I think that level of flexibility is something that is important for you to

feel empowered and have the autonomy to get to the same learning outcomes by flexing if you need to flex the schedule a little bit.

Dual Credit Requirements

There was a great deal of conversation around the topic of which students have access to this program, and dual credit requirements. The goal of Purdue's collaborative research project and the reason for using the facilitator model is to break down barriers to earning dual credit, however, each student interested in participating had to first enroll at the main campus as a non-degree seeking student. By the end of the summer, over 92% of students who applied to the program were accepted, but at the time of the professional development there was much speculation about who would be able to participate for college credit. It was common to hear concerns such as "You know, I, the one thing I'm really struggling with all of this right now is that we're telling kids, we want to tell kids it's okay to fail. But they can't fail into they get into this class." The teacher went on to explain further:

I know that we are we as a school are struggling to get kids into your programs, because you've put these requirements on us about how well they have to do on the SAT or the ACT or what their grades are to even take this class.

These conversations prompted project team leaders to confer on solutions such as offering the curriculum to any high school student interested in the course. While only the students meeting minimum requirements to be accepted into the program would be guaranteed transferable credit, there would still be the possibility for students to obtain credit through the College-Level Examination Program (CLEP):

What we can explore and we have not yet done this, but I think it is possible is we could look at credit by exam meaning we asked for a portfolio from the students at the end of the semester, that portfolio would include all of the work they did throughout the semester, not really anything new, just simply share back what they did throughout the semester. And then we could look at offering credit based on that work.

While getting students access to the program was a concern for the teachers, the project team leaders placed much more emphasis on procedures for identifying struggling students and removing them from the program. As grades result in transcribed college credit, unsuccessful

completion of the course could result in a GPA that could negatively impact future post-secondary applications and financial aid eligibility. Because high school students would be held to the same add and drop deadlines as the on-campus students, a ‘Student Success Coach’ was instated to give students the chance to withdraw, as well as check grades at strategic checkpoints before each drop date. One researcher shared:

I think we want to make sure we're supportive enough to get people where they need to go at the right times. So I'm gonna, I'll follow up that with a list of those [add/drop] dates so you have them. I just wanted to talk about him first and just remind you that [the Student Success Coach] will be helping you with that.

Registering Students

A central theme when registering students for Purdue’s Design Thinking in Technology program was to provide opportunities to underrepresented students. One researcher noted, “We want Tech 120 to be as effective as possible for high school students, and in particular, we want it to attract more students to Purdue, especially historically underrepresented students.” This is consistent with the goals of the high school, university, and Purdue’s collaborative research program, and is supported by research showing that any access to college level courses increases the likelihood that students will pursue post-secondary education (Troutman et al., 2018). At one point in the workshop a teacher inquired if we were reaching out to students or simply redirecting them. To clarify the position of the university and research team, the researcher responded “Hopefully we can remove just some barriers that are already in place. We don't want to force anybody to go anywhere, right? We want to make them not have barriers to go to the places they want.”

One of the emerging challenges with registering high school students for this program was communication between the school and the university. A form was created for student and parent interest in the program but use of this form was inconsistent. This was noted by one of the researchers early into the process:

What I'm also finding, I got a couple emails even one yesterday from a parent's saying, Hey I, we applied and just wanted to make sure and then I checked the list of interests and they weren't on it so. So we also might have people applying that didn't somehow communicate their interest to me.

Another challenge stemmed from a lack of transparency in the registration process. Students would start the application process but would not be informed if their application was pending review or incomplete. It was common to see email threads from the Purdue research team to the registrar's office with questions such as "I received a question from one of the students about their application. Whenever there is a chance, no rush, is it possible to see if his application has been submitted?" The research team remained in communication with the appropriate high school faculty and provided updates on enrollment status of students. Although it would seem from some of the student responses that uploading transcripts could still result in uncertainty. Teachers told the research team that their students had uploaded the transcript but the application does not show it is checked off. The research team shared with the teachers that they discovered this process may have some variability from student to student, and the formatting of some transcripts result in manual entry. Researchers communicated this information to involved students and teachers to provide a level of transparency in the process.

4.2.2 Professional Development – Identifying Barriers

A second reoccurring theme found from discussions in the professional development involved identifying barriers for the upcoming school year. Subcategories for this theme include communication, implementing the curriculum, navigating various programs that are specific to the university, parent concerns, school culture, gaining access to the course and university, students, and 'other'.

Communication

The importance of communication when piloting a program is high, and while a number of steps were taken to ensure a smooth week of professional development, there are always areas for improvement. In one example, accounts were created for teachers to fully engage in the workshop resulting in a number of confusing, automated confirmation emails with little information. This was noted by multiple teacher participants who noted that a checklist of what to expect, and a list of university terminology would have been helpful. One teacher recounted:

It doesn't matter what mode, but some sort of checklist that has it all like organized, where I don't have to scroll, and I can see it all at once. And maybe

some terminology, because I think it was linked in, but I was just like, ‘Alright, I’m on Blackboard,’ and then the next email said you’re added to Brightspace, and I’m like, ‘What? Brightspace?’

It is important to note that some potential communication barriers were successfully navigated as well. Teachers noted that they really appreciated a hands-on approach to the curriculum through modeling a lesson, working on assignments, and grading through submitted work with a rubric. One teacher shared:

Just having chance to ask questions and make sure that we understand expectations and know how to lead this course and its integrity, rather than what we might think it’s, it is or should be or how things should be graded. I just think it’s getting to walk through it with you all will really make sure that we understand what we’re doing, and we do it in a way that matches your integrity.

This was also reflected in the conversations around assignments, as teachers talked through their rationale for how they marked sample assignments “One of the things that wanted me to pull me away from full credit here was that said use there is a group of people under novice versus it with a single singular user here on proficient.” “So I was looking to see if there was consistency or not. But primarily based on this first one, first, we’re looking at stakeholders and location described, there was none of that in this literature review.” This not only provided a time for teachers to get immediate feedback on any rubric ambiguity from a variety of sample assignments but allowed for collective communication of expectations for future students as well. It also allowed teachers to speculate on how their own students would perform on similar assignments. One teacher noted “The literature, I think, is going, from my observations is going to be the more most difficult.” While another noted the detail provided in each rubric “I think the expectation that the rubrics are giving are generally higher than the level of detail I see from students.” This was not necessarily a negative comment, as another teacher followed up with “I love to hear other perspectives of teachers, but I think once they see Oh, like every little thing is impacting my grade, I think they will rise to that.” At the conclusion of the discussion, teachers remained optimistic “I think like I think we’ll see success and especially with how this is structured, it’ll really enable us to dive into those topics more.”

Reviewing and preparing a sample lesson provided the chance for teachers to not only find what works, but to identify what was needed as well. One teacher noted:

I did have a little confusion on my day specifically because it looked like each of the other days had all of the same sub-headings on the Implementation Plan document of like, okay, here's the big idea. Here's what to do in class. Here's what to walk students through and the meeting six had some of those but a lot of it was missing. And so I was trying to piece together, okay, what of what I'm seeing in this document is just internal notes for the instructor to keep in mind versus the content that you guys actually want the students to receive. So that part I think, was a little confusing from like the user experience standpoint of like, having clear separation would probably help with that in the future of like, here's stuff for the instructor to know and think about. And then here's the stuff that like we actually would like for you to make sure it gets out to when you're when you're teaching.

Another teacher found clarity after teaching their lesson:

I did personally have a little bit of trouble understanding the input implementation of the Venn diagram for that lesson. I thought students were sort of creating their own categories there. And then, as we experienced the lesson, I understood it much better about how it related specifically to the literature, the observations and the interviews. So I thought that was a, it was nice to see it, but I wasn't I'm not sure what led to the disconnect before that for me, but I didn't quite get that part before.

As teachers would need communication and support from their administration to be successful, steps were made during the workshop to identify needs. Among these were common planning times to meet with a representative from the university acting as the Student Success Coach, budgeting for prototyping consumables, and identifying which students are taking the course for dual credit as opposed to high school credit only. As a measure of support, the research team drafted and submitted an email at the conclusion of the workshop to school administration regarding these potential needs to help facilitate communication between university researchers, teachers, and school administrators.

A key component of the facilitator model is that students' work is reviewed at multiple points throughout the process with a 'Student Success Coach' providing feedback to both the teachers and the course coordinator at the university. It was restated for clarity by one of the

researchers that high school students would have an advantage as they would be able to apply feedback from their teachers before submitting for review for college credit:

Were you suggesting then that after students received feedback from their [teachers] that they, before submitting it for the Purdue graded ones, that they be told, hey, look, you should revise your college grade because this is something that will affect your college transcript? And also, just so that you have that second learning opportunity? Are you recommending that everybody engage their students to make those kinds of revisions?

This was confirmed by the research team, “Yes, students should go for mastery, and not just where are they in that snapshot in time because this should [show their] growth over that semester.” This also bears significance on the students’ status throughout the course of the semester. As grades are directly transcribed and individual progress is monitored, recommendations can be made to withdraw students from the college portion of the class to protect their GPA. As explained by one researcher:

There are drop dates for the course, and we have to be very mindful of that. And honestly, [the Student Success Coach is] probably going to lead a lot of that. But we want to be able to assess where the students are and take your, your assessments of the students to understand kind of where they are with the course because the last thing we want them to do is to get a D or an F. And that follows them forever on a college transcript. Right? We don't want to set them back by doing this experience. So we have there are a couple of dates, there are three. One is September 7, where if they dropped, the course does not appear on an academic transcript. So that's the best time to get everybody out. If they if they're not participating or they, you know, they just stopped showing up to class something along those lines let's, let's drop that so we don't hurt that that person. In September [the Student Success Coach and I], we'll check in on the around these dates. September 21 is the last day to withdraw from a course with a ‘W’. A ‘W’ is on a transcript, but it's not included in the GPA calculation so it doesn't hurt that. October 27 is really the last day to get out of the course if they're doing poorly for, you know, whatever reason we want to give them that opportunity to drop at that point there. They have an option but depending on their grade, which

hopefully we don't ever have to go this route, is you either get a 'W' or a 'WF' meaning you withdrew, or you withdrew with a failing grade. That's what the instructor indicates. So [the course coordinator] would have to indicate that. Hopefully we don't get that, it's still just a withdrawal because of the trajectory that they are on that is recorded on their transcript. Still, whether you get a W or WF, it doesn't calculate into the GPA, but people still see it. So we should not have anybody really, if everything goes right, nobody with a bad grade or 'WF'. I think we want to make sure we're supportive enough to get people where they need to go at the right times.

Support from the Student Success Coach and withdraw dates were iterated multiple times throughout the workshop to encourage any parents or students who may see the risk of failure as a potential barrier to enrolling in a dual credit course.

Implementing Curriculum

Another potential barrier for piloting a new program is the implementation of the curriculum. Teachers expressed their relief that while learning objectives and student expectations were clear and concrete, and rubrics were detailed, the delivery of course content was designed to be flexible. One teacher noted "I like that it has not so much programming that we aren't gonna interject our own personalities and understanding of our students into it." Another followed the comment with "I like it, because there's structure there to follow that yet, like [the other teacher] said, you know, there's enough leeway that we can put our own spin on things." This was echoed by researchers as less of an option, and more of an expectation:

From that script perspective, I would encourage everyone, whether they're [high school] teachers, or our instructors here on campus, to read over the materials, try to understand the purpose and the idea and the way we're getting there, and then use some level of autonomy and creativity. You know, don't throw it all out, but if you've got a more relevant approach that would be a small modification, you know, kind of academically a small modification, but it would look different. In other words, you know, as current events pop up, or if they're, they're items that are more interesting for high school students and [your school], then what we've come up with for college students at the university, make those little switches and

switch out those examples, switch out the approach a little provide that level of scaffolding so the students can be successful.

While students were not involved in the summer workshop, speculations were made about potential scaffolding for students, and where they may struggle most. One teacher commented:

My only concern about homework, I haven't had good luck at getting the students to actually *do* homework. And somebody, some other people, put it on the board also. So, if we go [online due to Covid-19] I'm just concerned things may not get done.

Homework continued to be not only a concern, but an expectation teachers looked forward to, as one commented “I think honestly, I like the idea of not having them do homework.” While the justification of homework is debated in academic circles, one teacher reflected:

When I was in high school, there was a lot of expectation of a lot of homework. And I and for some reason, I don't know if this is good or bad, but it's changed. That, you know, schools don't want that expectation anymore, but college hasn't changed. You know, we keep changing what we do to make it more accessible to students, but then they get college and then the students don't know how to do a lecture that's an hour. They don't know how to take notes. They don't know how to do all of those things. You know? They don't know how to read 100 pages in a boring textbook by next Tuesday, because we don't expect any of that out of them in high school.

Teachers expressed concern about how students may compare new curriculum to previous classes that they may be similar. As is typical for schools with pre-engineering courses, the design process can be taught in a very systematic way, which is not necessarily in-line with design thinking. One teacher offered:

I think that might be the hardest thing with communicating with students is the nature of it. They're just so, they're very often programmed [to follow a set of steps], and we do a good job at our school. I think it will be hard to try to un-program them a little bit from thinking most problems are solved in very step by step ways.

A curriculum specific concern from multiple teachers was the emphasis on interviews and observations for iterations in the design process. One commented “Our students struggle to find people to interview and I mean, authentic people that are totally related to whatever area that they decided to go with.” While another noted that even when they find someone connected to the problem, they struggle with necessary 21st century skills to gain valuable information:

I think that one of the challenges I see is whether they're interviewing or doing surveys, they're not always getting at the root of the problem for the users and so I guess a question that I have that's maybe a little more rhetorical is what additional activities and supports can we put in place to help better teach the art of question asking?

Similar to interviews and observations, another teacher noted that research could be an issue, especially when considering that many the university utilizes software to check for plagiarism “Something I struggle with, with my students, is they copy and paste and don't summarize. And so we may have to put some scaffolding in of how to actually summarize information.”

Concerns also emerged related to the emphasis the course places on functional prototypes to demonstrate design validity. As noted in the section on communication, this potential barrier due to material cost was sent in an email to each school’s administration to help facilitate that internal conversation.

Navigating Software Programs

Purdue University and the Design Thinking in Technology course utilize a number of web applications that are likely unfamiliar to high school teachers. A short list would include the Brightspace learning management system (LMS), CATME for teammate evaluation, No More Marking for making comparative judgements, Google Documents for each class’s lesson plan, Google Jamboard for online group brainstorming, and Microsoft Teams for remote teaching.

Even learning the layout of one new program can be intimidating, as one teacher noted before the workshop began, “I am least comfortable with working with the online platforms (BrightSpace) and helping students navigate it as well.” As the facilitator model enables teachers to have frequent contact with the university, programs such as Brightspace, the learning management system, were focused on the most, while other programs were briefly touched on

such that teachers could see them and ask a few questions about how they might use them, while knowing that there would be more assistance during the school year when they needed it most. Unfortunately, this lack of depth led to confusion on programs names and uses, as seen by one teacher's comment "CATME [software] is the No Marking [software], isn't it?"

Access to these software programs also presented its own challenges. As teachers would need to be confident in helping their students navigate the interface in the fall, both student accounts and instructor accounts were created for teachers. Unfortunately, this also created confusion when accessing them as they not only used different usernames and passwords, but used both corporate and university accounts. One teacher noted this when having difficulty accessing the program, "Mine is still saying that it's an invalid username or password when I do it under corporate. Am I supposed to still do Purdue? West Lafayette?"

As teachers prepared to give sample lessons they navigated back and forth between the learning management system and an implementation guide used by course instructors. While the use of these programs was demonstrated, and researchers were made available to help answer questions, it remained a daunting task after a full day's schedule. One teacher noted, "I find the going back and forth between Brightspace and the Implementation Plan document very cumbersome but as I get familiar with the material, I am sure it won't be." Another commented "I know maybe I just need to play around with it more. But when I went through [Brightspace], I was like, I don't see like content." This same sentiment was echoed by other teachers in more detail:

So, I actually first started in Brightspace. And I looked at, I was in the instructor view, and I was looking for like, course syllabus, which I think was in there but also like an agenda or just the content for the class in that and then I could not find it so I went to the Implementation Plan. And I started to see that it was in there and started to piece together a little bit of that. I think I did find old slides in the Brightspace, which we had already talked about how the conversion from Blackboard to that kind of linked in old stuff and didn't remove everything. And so looking at the Implementation Plan, I did have a little confusion on my day specifically because it looked like each of the other days had all of the same sub headings on the Implementation Plan document of like, okay, here's the big idea.

Here's what to do in class. Here's what to walk students through and the meeting six had some of those but a lot of it was missing.

As noted, Purdue had just made a learning management switch from Blackboard to Brightspace, resulting in new user interfaces than what the researchers were familiar with. The navigation strategies and barriers faced by this teacher were similarly reflected by another:

I kind of started at the Implementation Plan, kind of reading through that. And as I read it, I kind of realized that I needed to look a little bit around it as well the lesson would be not to it and, and kind of following it to understand where it was in the whole scope. There were some parts and reading it that I didn't quite understand. So, at that point, I went to Brightspace and tried to look at it from a student point of view, because I think that some of the things out there were a little more. I think that the Google Doc was, you know, a little bit, you could tell it was built by teachers kind of planning on the fly along the way, adding things taking things out. And so, and there was some more room for kind of personalization in there, which made it a little bit harder at first, but I think once I kind of saw the student point of view, I looked at the old slides that had been transitioned from Blackboard, to try to get the idea of what a class might look like.

As the week continued, and teachers became more familiar with the layout and features such as grading and online rubrics, they indicated feeling more optimistic regarding navigation and functionality.

Parent Concerns

While the aim for the facilitator model and other dual credit programs is to provide opportunities to the students, the parents are a key part of the process. One concern that was brought up by researchers multiple times throughout the workshop related to clarity in the message the parents receive about the application process. One researcher reiterated:

I have to note that the students are admitted as non-degree seeking students for this course. And if they take something online, or if they take something over the summer, so as instructors just let them know, you know, when you can, when it makes sense, that just because they're admitted for this doesn't mean they're

admitted for a degree program. So they do have to reapply to be admitted as a regular, degree seeking student at Purdue. So there is a little bit of a difference there because depending on the program, there's different admission requirements and things like that per major.

While admittance requirements to the course were at first confused for admittance requirements with the university, by the end of the workshop it became clear that proficiency in a college level course could aid students in future application processes. One teacher shared:

Well, it's funny, [I was having a] conversation yesterday about [one of our students] because he had a lot of D's from his first year or so of high school. And now he's here [after transferring schools]. And even though he's getting, you know, B's and stuff now, like, there's no way that he could, he could go right into Purdue. But, you know, he'll also have all of his high school credits by the middle of his junior year. His senior year, he could just be taking those college classes and still transfer in.

Another theme to emerge from parent concerns relates to financial responsibility. As one of the goals of facilitator model dual credit courses such as this is to break down barriers that may stand in the way of underrepresented minorities taking college level courses, questions emerged around required books and materials. While Tech 120: Design Thinking in Technology does not have a textbook component, one of the major aspects of the course involves prototyping. When specifically addressed, one researcher noted:

So, we don't have a budget. I don't know what your budgets might look like, but we don't supply our design teams with any money. So, we make the assumption that whatever projects they come up with could either be low resolution or if they've got some money to invest, it could be a little bit more complicated. At the university level, students expect to spend a little bit of money on books or other supplies, and we assume that that fits for the high school level.

Teachers were encouraged to have internal conversations with their administration to further discuss funding for projects. This was further aided by an email drafted and sent to each school by lead researchers on the project to help facilitate discussion.

School Culture

School culture can play a role in both the teachers' and students' approach to curriculum. Teachers do not come into professional development sessions as 'blank slates', they have years of experiences that have shaped and molded their expectations, and all of the teachers participating in the workshop had strong feelings about past professional developments. One teacher noted on the first day:

The biggest problem I have with some PDs is that it's not really run by our school. It's often framed for a traditional high school experience. And not only are we a little bit different in a lot of ways, but we're also we seem to change every year too. So, we're finally starting to kind of figure out our model and so PDs are becoming better equipped towards that model.

Another teacher voiced a common concern "The biggest challenge with PD is can I use it in my classroom?" A third teacher reflected "I'm notorious in our school for not liking PD," and "I'd rather you just like, give it to me like really quick and then I want to go practice. I'd rather then let my practice and failure help me get better." Still another teacher noted "Two things that always drive me nuts about PD is one, as educators we are preached at to differentiate, but professional development never differentiates! I don't learn best the way that somebody else learns." They went on to say "The other thing that just always kind of drives me crazy at this point is like I've been doing this so long that things are starting to get cyclical." The last teacher reflected of their experiences,

I agree that like, regardless of whether it's the right level of, like, knowledge for the for the users, for the PD generally doesn't always have space built in for people who need time like to be, like, quiet to process and then respond, versus people who need to like collaborate with others. And I'm generally one who like needs a moment to just kind of pause and take it all in, think about it. Kind of like process it and then talk to others about it once I've made sense of it myself.

As students, the school culture shapes performance expectations on homework, projects, and assessments. After reviewing several rubrics one teacher noted "I think the expectation that the rubrics are giving are generally higher than the workplace the level of detail I see from students." While another agreed, but was quick to comment "But to add to that point, I don't think that it's going to result in fails across the board," and "I think once they see, oh, like every

little thing is impacting my grade, I think they will rise to that.” Teachers continued to remain positive about student outcomes after this comment with statements such as “I also think that they can be coached.” And “I think like, I think we'll see success and especially with how this is structured, it'll really enable us to dive into those topics more.”

In the last days of the professional development, a ‘big picture’ view of the course started to emerge, and the teachers made a shift in focus from students and teachers to the role of administration. One teacher noted “I wonder if admin would be open to changing other classes or how we do [projects] that would help. The new coming, assuming that we're continuing this and that the new students coming into Tech 120 would be better prepared.” Some teachers were doubtful, expressing concerns such as “I would love to go back and say, ‘this is why we need to change this.’ But I don't feel like I have the authority to do that, because that's not why I did this training.” Another teacher who had already had similar discussions at their school seemed optimistic.

[Administration] is on board and probably adamant about [making changes to other courses]. I don't know what change looks like for you all, but it might make sense to kind of survive this this fall and then use this as a reflection point for the next fall in terms of how it might impact curriculum.

Other teachers had thoughts on financial and scheduling roles the administration could play, with comments such as “I think we're gonna have to present to our administration, hey, you need to allocate some budget money.” Reflecting that “We'll have some Raspberry Pi's, we can 3D print things, but even the small five, ten dollar purchases will be a roadblock to some of our groups.” Another teacher noted how much more productive they were as a group and wondered aloud about ongoing professional development:

Could we bring this up to admin so that we could get at least [our school] together? Have the three of us available at the same time [for weekly meetings with the Student Success Coach]? I don't know about your scheduling. But if we bring it up to them, maybe they should put that into their planning.

Working with the University

When considering the alignment of Tech 120: Design Thinking in Technology as a dual credit course with the university, several questions and concerns emerged for a fidelity of

implementation. While some concerns were simple, such as participation “Purdue has different attendance and tardiness policies. And I thought it was like, once you miss three classes, then your grade starts to drop is, is that something we'll need to hold our high school students accountable to as well?”

One of the researchers made the observation that this course can act as a kind of a window into the workload of a college course, and the advantage the students may with a teacher to help navigate the process. “It's often the students that are highly successful in a highly structured environment, high school, that end up coming to Purdue and that's, that's a little bit of a mismatch and we appreciate your students tackling that that challenge.”

One concern that emerged was focused on what the transition may look like for their students, and what kinds of supports may be on campus. A teacher asked:

What are some of the other kinds of supports that you guys have to support those students? Because they're often students that will get walked over or aren't represented well in technology and engineering, or they'll have other stereotypes of voices that are even louder than theirs and theirs gets under shined. So, what are some of those other supports?

The theme that seemed most prevalent throughout the workshop was how the university may work with students that struggled early with their GPA before transferring schools or finding their stride. One teacher noted:

But you know how many of our kids do we have like that, that come in, and struggle, and or, or more importantly, they come from another school struggling. And then they find success with us, they find success doing this design thinking, which is what our entire school does.

This group of teachers was very invested in their students, and the more focused they were on the idea of having to apply to the university, the more concern shown through with comments such as “The meeting we had this morning was really kind of heart wrenching with the registrar people...” “...So my morning homeroom class is all of the kids that are academically behind or are troubled kids...” “...it is disheartening to know that like, I don't know if any of my students would even have a chance at getting into Purdue.” The teacher continued “It's emotionally heavy to know how hard it is for our students to get into this school.

And I think it's great, it should be hard. But on the other hand, does it defeat the purpose of the whole program?"

These concerns were addressed throughout the week by multiple researchers and university representatives who remained optimistic about using this program to serve the needs of historically underrepresented students. One researcher emphasized points made earlier in the day:

Usually we think of Purdue as kind of being a machine and not necessarily being flexible. But you know, you heard the conversation this morning with our Dean about how he's kind of piloting this uncharted territory, and we've got this special situation.

Another researcher pointed out:

Nobody's been denied yet. So I think, let's just keep going this way, and see how long it can go and then enable [us] to do the research that demonstrates how this is impacting all the students, and then how this is impacting the teachers and what kind of support the teachers need. And we can use that as a leverage point because right now, it seems like we've got a special opportunity.

One researcher reflected on students that may still take the course for high school credit if they did not qualify for dual credit, and still potentially benefit from the course as a way to advocate for dual credit. The researcher explained:

I'm optimistic that we will be able to open this up and offer it at least for high school credit to a lot of our students who maybe wouldn't have qualified for the dual credit, and then we can maybe get some really good stories about you know, who knows, somebody. We have students who would potentially win our classes' design pitches and aren't getting dual credit. That's a story that would maybe make its way up and hopefully start to show why actually giving more students access would actually be beneficial to Purdue.

This was not the only time when it was pointed out how a dual credit course would benefit students who otherwise may not have the normal GPA requirement. One researcher spoke to student self-efficacy "Hopefully by the end, they are feeling like, Hey, I was successful in Tech 120. I think I can do this." Another commented "It builds their sense of confidence, we hope because they take college level class, they are Purdue University student and they have

success. That's, that's a good thing for them.” They went on to point out how success in a high-level course is looked on favorably by the university:

It gives them a history. I mean, this is kind of like getting a credit card and having a good credit history and then going for a loan later, they look back and see, ‘Oh, you did something like that. You took a college level class, and you were successful.’ That's a good indicator of further continued future success.

This sentiment was echoed by guest speakers from the recruitment office, assuring teachers that taking the right courses and fulfilling the subject matter requirements has a positive impact on the evaluation of student applications. Application review goes beyond grades as each student is evaluated holistically to see how they have prepared themselves for college.

One researcher, familiar with the application requirements pointed out strategies for students who may not be successful in their first application:

I've had a couple of students in the last ten years who have their heart set on Purdue, but they simply can't get in. So they've gone to another college, like Ivy Tech, for example, for one semester, because the transfer requirements are very different from the first time to admit requirements.

One message remained clear throughout the discussion, keep encouraging your students. One representative from the recruitment office was very direct in the influence that teachers have with their students. They emphasized that teachers have the greatest influence and impact in encouraging students to apply, and that they will never know if they would be accepted if they do not fill out an application.

By the end of the workshop, it was clear that both teachers and representatives from the university were very invested in the success of not only the Purdue collaborative research program, but more importantly the students it would impact.

Preparing Students

Preparing students for college level expectations and coursework can be intimidating, especially if the foundation of the course is already similar to something the student has already experienced. One teacher asked:

I had thought if we have some students who are taking this, they might find parts of it redundant. [So] what resources do we have ready to help make sure that they

get something meaningful? Like, ‘Hey, this is leveling us up!’ or, you know, ‘What are we getting extra out of this?’

Teachers came back to this same point later in the week:

The only thing that comes up for me is just better clarifying like the ‘why’ to it because the reteaching of it doesn't intimidate me. And I think that a lot of it will be kind of similar, but just like really, really hashing out like why we're still going to have them go through a new learning and understanding of it. And like, pointing out that this is going to be deeper, you're going to start to learn different methods, and strategies, and new terminology.

One teacher commented that students may already be so ingrained in methods that have proven successful for them that they may be unwilling to change “I think it's a bit of ego sometimes with the students that kind of can get in the way and sort of a ‘If I can solve this problem without it, why would I?’” Another teacher even remarked on how students may need to be ‘unprogrammed’ sharing:

So, I think what might be the hardest thing with communicating with students is that nature of it. They're just so they're very often programmed, and we, we do a good job and at our school, I think to try to unprogrammed them a little bit [from thinking] most problems are solved in very step by step ways.

Throughout the week various panels were assembled for the teachers to interact with. One such panel consisted of professors from various majors that students may encounter after taking Tech 120: Design Thinking in Technology. In asking for advice in preparing students to engage in problem solving activities, one professor shared how students often jump to the solution first, and try to make the rest of their work align instead of doing the research to lead to a targeted solution for a specific problem. To push-back against these early solutions and encourage students to be more creative, the professor shared how they invite industry representatives in to turn down ideas. The professor offered to serve in the same capacity to throw out high school student ideas if needed throughout the semester so that the teacher facilitators could continue to be seen as the ‘good guy’ when helping students move on to the next step of ideation.

Throughout the professional development, many reflections were made about how to best prepare students for post-secondary education through their experiences in the Tech 120 course.

In summarizing the applications that this course could have with students after high school, one researcher noted:

Tech 120 does allow students to experience some challenge and struggle with a project, with a very complex project, with peer collaboration. And the reason why I'm excited about that is because I think it gives students practice with something that can be incredibly useful for college and beyond. And that is knowing when and how to seek out help. And so, I think in particular, this version of it at the high school level, is something that I'm especially excited about because not only will they have [a Purdue Instructor] as a Student Success Coach, but of course, then they have you, their teachers or coaches that they can go to as well.

These quotes represent issues and concerns voiced by multiple teachers throughout the professional learning experience. Concerns were documented, shared with the research team, and categorized to predict and plan for on-going supports throughout the school year.

Other

In providing professional development, there were many unforeseen distractions for both teachers and researchers alike. Teachers had just ended their grading period for students the night before our first scheduled meeting, the university made a major learning management transition requiring courses to be recreated in a new environment, and it should be acknowledged that both the summer training and semester implementation of this course occurred during Covid-19 regulations, a time of social isolation and many disruptions to the daily classroom routine.

While researchers were familiar with the functionality of Microsoft Teams when delivering content to students, the software behaved unpredictably with guest accounts or web based accounts. Participants using Chromebooks for example could only see the active speaker. Some teachers had trouble accessing university accounts that were created for them and resorted to using a guest account only to find that they could not see messages or click links shared in the software's chat window. Still another teacher found that after exiting the program, they could not only still hear the conversation, but their microphone was active as well. For another teacher the internet connectivity was temperamental causing audio issues. They resorted to using the microphone from their cell phone while sharing their screen from their laptop. While all of this

was successfully navigated, it did take time and troubleshooting to discover the cause of the problems.

Researchers had been in contact with the schools' administration about availability in advance of the professional development. While dates and teachers' schedules were provided, it was not clear that the workshop would start immediately following grade finalizations from the participants. This was a contributing factor to distraction throughout the first day as one teacher who was having difficulty accessing course content shared:

I don't even remember if I did talk to ITaP (Purdue's technology department). Maybe I did. I mean, you know, like, I hate to sound whiny and gripey, but like, having this happen... like grades were due today, and like, I just haven't had any time to think about this.

The stress from having grades in was exacerbated by a design challenge that was given to participants in advance of the professional development. While the design challenge provided teachers a chance to communicate with the other school and a common reference on which the rest of the workshop would pull from, it was an additional ninety (90) minute task that not all of them were in the right mindset to complete. One noted "I couldn't, I couldn't focus on any of this until I finished the other stuff. So I finished that, and then it became I could go right into this. And so for me, that was a lot of stress." While another pointed out:

We just had to have grades in and I didn't really get a chance to think much about this. I would have, had I had time off. So I understand that it's not your control, but I felt very anxious about how little I knew about things, and what I know today at the end of day three is night and day different than what I knew on Sunday trying to figure this out.

Covid-19 restrictions and uncertainty also played a role in the professional development. There was speculation of what it would be like to go back with the new restrictions "It's gonna be it's gonna be hard, psychologically for me to go back with a mask." As well as collective brainstorming, strategizing, and sharing of methods. One researcher who had already started planning for face-to-face classes offered:

The conversation that I had yesterday was, essentially, the teacher would have the for lack of a better word. We called it a refuge. So the teacher would be able to be in one spot, and there'd be a 10 foot radius to the nearest seat. And then the

students would have six feet if they're face to face, three foot six inches shoulder to shoulder left to right.

It was clear that 'pandemic fatigue' impacted teachers in similar ways to students, as one teacher reflected on how their surroundings impacted their level of engagement:

It's just different. I mean, like, I'm at home, and that means that I have to do laundry, and I have to deal with the dog, and I have to deal with my kids, and my [spouse], and I have to make my own food. But if I was there, I would have walked down from the hotel room, grab breakfast at the hotel, come to you guys, we would have had lunch together... Like, it would be a working four-day trip. As opposed to the fact that, you know, for four days, I'm sitting in my house doing all of this stuff that I wouldn't be doing [if I were there].

Another teacher reflected on how an online professional development forced them to be sedentary, where they are normally used to moving around the classroom and interacting with others:

On the first day I turned my camera off and I was doing yoga, you know? Because I can listen, but I needed to move. I'm used to having 12,000 to 14,000 steps on my watch, right? And today I was just looking, I usually get up, and I run, and you know, do all my workout and stuff. But I have never had 1000 steps on my watch.

While each event provided its own unique challenge, the research team and teachers adapted and continued to support each other moving forward. Time was allocated each evening for when professional development leaders would be available, reflection time was scheduled each morning to start the day, and the workshop concluded with a large group discussion of what was needed and what to expect for the school year.

4.2.3 Professional Development – Planning for Ongoing Support

One of the keys to the facilitator model is the ongoing support for teachers as facilitators of the curriculum. This section highlights the introduction of strategies and resources provided to teachers during the professional development. Subcategories for this section include student exemplars, grades and feedback, students' transition to campus, weekly update meetings, and other communication.

Student Exemplars

When outlining a semester class in four days' time, it can often help align expectations to start with a big picture overview and end product. Researchers modeled this with the teachers, as they showed exemplar videos of previous college-level students, explaining their end-of-year projects. Many teachers commented on how valuable this was for them. In reference to the design competition that is part of the final project, one teacher commented "I think it was really valuable today that you showed us videos from actual Purdue teams, especially that third year student one when I can't remember who I think it was. I was like, how did they not win?" Another teacher reflected on how they might use it in their classroom to prime their students "I think that showing the end product is extremely insightful for kids to graph like the big picture." Still another teacher focused on the content of what was shown and how their students may interpret it:

That example was so good because of the pivoting they did. I think, it really showed the value of the different steps of the design process because you see how they got to their end by doing those things. By doing the research, by doing the user interviews, by testing, and so a lot of students could maybe use an example like that to say, 'Oh, well we can't just check this box, it actually has to inform our final product.'

Teachers were provided with writing samples of various assignments, and design journals showing a work in progress of student groups. While appreciated, the recorded demonstrations by recent students was the resource that not only generated the most discussion, but had teachers asking "Can we use that [recording] with our students?".

Grades and Feedback

One way the facilitator model helps with college credit and articulation is by having student submissions graded by an instructor from the university. Each morning, researchers would conduct a virtual 'KWL' meeting, where teachers were asked to identify something they know, want to know, and learned from the previous days (see Figure 13). As the Purdue instructor would play a large role in the success of their students, teachers were interested in not

only how best to prepare students, but who would be responsible for evaluating student assignments. One researcher outlined the plan:

So I think the plan is that we're going to have you grade basically everything, giving the students feedback on all of those assignments. I'm going to go through and kind of spot check on different assignments and see if that lines up about the way that I think it should, and then at certain points, it's going to be before those drop dates and those important dates for students, they're going to submit a bundle of assignments to me. There's a way we can categorize the assignments [in Brightspace] as Purdue or [high school]. So they're going to submit three or four different bundles [of assignments] to the Purdue category. And I'll go through that and give them a grade, I normally grade Purdue college students. So they will have already had feedback from you, and they have the chance to go back and make updates to that assignment before they turn it into me.

June 11 - Topic: Tech120 Dual Credit Course - Facilitator Model		
What I know	What I Want to Know	What I Learned
From [REDACTED]: Much of the Tech 120 schedule will be dependent on our opening plan. We've got 5 scenarios in the works, everything from "business as usual" to	Aside from the Brightspace assignments, what other deliverables do students have to complete along the way? (I'm assuming it's the design journal, but not sure if there is more).	Award money from <u>pitch</u> contest goes towards tuition (it's scholarship money currently), but they are working to let it be used for starting a business.

Figure 13. *Daily KWL Chart*

Wanting to make sure that the teachers understood the impact they could have on their students as a support, another researcher asked a clarifying comment:

Were you suggesting then that after students received feedback from their coaches that they, before submitting it for the Purdue graded ones, that they be told, 'hey, look, you should revise your college grade because this is something that will affect your college transcript, and also just so that you have that second learning

opportunity.’? Are you recommending that everybody engage their students to make those kinds of revisions?

It was clear that teachers would play a key role in supporting students academically by providing feedback and nurturing a growth mindset environment. While this can act as a motivator for many students, it was also acknowledged that any students interested in the course were encouraged to enroll, even if they may not be academically ready. As the grade from the course is directly transcribed, a poor performance could actually serve as more of a barrier. To address this, safeguards were set in place to counsel students out before it was too late, as explained by one researcher.

We want to be able to assess where the students are and take your [teachers’], your assessments of the students to understand kind of where they are with the course, because the last thing we want them to do is to get a ‘D’ or an ‘F’. And that follows them forever on a college transcript. Right? We don’t want to set them back by doing this experience. So we have there are a couple of dates, there are three. One is September 7, where if they drop it, the course does not appear on an academic transcript.

The use of a Student Success Coach here to assess student work and advise students serves to ensure college transfer and articulation, maintain collaboration with high school instructors, and offer student supports. It was made clear to the teachers this was not only meant to be a good experience for students, if properly executed, student could participate without taking an academic risk.

Student Transition to Campus

Throughout the week there were several panels who spoke with the teachers to offer a variety of perspectives on the impact for implementing this course. One session focused on accommodations and support systems for transitioning students to campus. Some supports included clubs to act as allies to students such as the Minority Technology Association and the Women in Technology Association. Curriculum supports included academic tutors and academic coaches, such as BEST, Building Excellence for Students in Technology, where students can get their own personal academic coach for a range of classes from math or physics to Polytechnic courses.

As leaving home and being in a very different environment can be disorienting to students, there are programs to introduce students to the campus in a more structured and gradual manner. One panelist introduced STEM specific transition programs for coming to campus, such as a five-week STEM academic boot camp, where students complete courses in math, English, and design thinking, to provide structure when acclimatizing students to campus while providing the opportunity to reduce their semester course load.

A second panelist introduced a similar program for incoming freshmen, Summer Start. Summer Start is a direct admit program, to provide scaffolding for students that the admissions board may have reservations about. They may have qualifying SAT/ACT test scores, but lower GPA, or a lower GPA and a qualifying test score. Students in the Summer Start program come to campus in July, take seven credit hours before the fall, are placed in a learning community for the first year, and receive a coach for all four years at Purdue.

Of both programs, the panelists emphasized the advantage of introducing students to campus in a more gradual way. One panelist reflected on the reduction in anxiety when taking courses with only one-thousand (1000) students instead of coming in with 40,000 - 42,000 students. Another panelist emphasized that advantages extend past getting ahead on credits, as students have the opportunity to meet with faculty, advisors, and both the dean and associate deans emphasizing how transition programs prevent students from being lost in the system.

It was clear that the transition team was invested in supporting the teachers, as they outlined the plans they had for a professional development day before the pandemic made face-to-face planning more challenging. Arrangements had already been made with building principals for teachers to travel to Purdue, take tours, and receive information from the transition team to share with potential students.

After meeting with the panel, the teachers reflected on how they may best counsel their students, knowing that many may be nervous about applying to Purdue and being away from home. Teachers seemed comforted that there were advocates for their students and groups of student ambassadors to create a sense of community on campus, points that were otherwise unknown and would likely be unnoticed before the panelist talk.

Weekly Update Meetings

One thing that sets the facilitator model apart from other dual credit models is the emphasis on collaboration between high school and college instructors. During the professional development, comparisons were drawn between the ongoing training for on-campus instructors, and this group of teachers who are acting to help facilitate the curriculum. The Tech 120 course coordinator reflected:

I spend almost two hours a week with the instructors, but that assumes that they don't know the content very well, because they're learning it just in time. In this case, we've already spent a week I mean, that that could be half an hour to an hour weekly.

Teachers, understanding that they would effectively lose a half hour to an hour of planning time throughout the week for these meetings, expressed interest in how they may help while also showing some reluctance to committing to a full semester. "I'm hesitant to answer not knowing how it's gonna actually feel. Maybe it'd be better to start with some regular ones and then as we feel, or as things approach, we could communicate." Another teacher had a different idea, "If we ask for a half hour and we need an hour, it's gonna be really hard to go back. But if we are given an hour, that's available."

When asked to clarify how the time would be spent, the researcher explained:

I had originally planned for maybe 30 minutes plus each week. That is kind of a check in, see if there's any major modifications that need to be made or that were made [for on-campus students], just see how your students are doing, and then give any updates as far as what to expect for the next coming meetings. So I plan on keeping those relatively short.

In the end, the group decided to ask for an hour of shared meeting time from the administration. It was particularly incentivizing that if they did not use all of it with the researcher, they could help each other plan lessons, compare how they graded paper, or just have extra time throughout the day.

Other Communication

Throughout the professional development, various school year supports were discussed. One such support was the use of an undergraduate student who had already completed Tech 120: Design Thinking in Technology to act as a teaching assistant or even to meet with the class for a question-and-answer session. One teacher was very excited about the possibility of having high school students interact with on-campus students, and described what they had envisioned for the role of such a student:

Just to come in and talk about who they are, a mentor. More of like, almost like peer-to-peer support, but obviously, it's high school with college students. Just someone that they could talk to that's not a teacher and get advice. Maybe share what they're struggling with in the class and just feel like, oh, wow, there's an older person investing in me who has gone through this course before.

The role of a university instructor as a Student Success Coach was also introduced to teachers, as not only someone to grade papers, but to provide feedback and respond to student emails as the main point of contact. While the Student Success Coach is not expected to have all of the answers, they can act as someone who can connect students to the right person. One teacher was very excited about having students receive feedback from a university instructor:

Personally, I would love somebody else to give feedback. You know, they, the students, kind of get used to that. I've seen, at least my classes, get used to what I'm going to say, and having somebody else come in for those students that are like, 'No, I do understand this', you know? And trying to guide [them because] maybe it's tagged differently, maybe it's because somebody else [explains it differently], maybe whatever. So I always value when somebody comes in.

Teachers also used each other as resources throughout the professional development. At one point, parallels were drawn between an interview assignment from the Tech 120 curriculum and a similar assignment that students often struggle with. One teacher reframed the question for the entire group, asking "How might your students gain access to people to interview? Anybody else thinking of a solution to that?" Prompting a teacher from a different school to respond:

Yeah, we've had like some issues, but I feel like overall this year we've had pretty good success getting [students] in front of people. And so I think [the other teachers at my school] and I just really, like, rely heavily on our network. Our

personal and professional networks, and let them find us connections and people around the city. So I would say after Christmas, we had like a minimum of eight different professionals coming in per cycle to talk with kids in small groups or big groups, and we are always pushing them to follow up with those people. So I will probably continue to do that too. Just like use people that know people to find interview candidates.

Another teacher noted how social media may be used to help with finding people to interview:

I think something else that I'll do this time around is walk them through how to use certain like social media platforms to find and recruit people. I know it's a little harder for them because they don't have big professional networks, if anything at all. Um, but showing them like, okay, here are certain hashtags you can put with your question so that it'll populate and in certain things that people are trending and following and they might see, oh, someone wants to find out about this. I know a lot about that. And if students were trying recruit for a specific thing. I had them like, tell me what their topic was, who they were looking for. And then I put posts in LinkedIn or Facebook on their behalf.

A third teacher realized that they had already met several people who enjoyed working with their students. They offered the idea of creating a centralized database of not only willing participants, but notes on interview questions and topics:

Just keeping a database of all the people we've ever interviewed. And then in those, keeping a list of notes from those interviews, like what questions were asked and what responses they gave. So that let's say if we come to a situation where people can't, like, find more users, or that person isn't willing to be interviewed, but again, at least we have record of what they shared. And if the topic is similar, and the responses are similar, they can still use that info from a past interview that a different team did.

As the discussion continued it became clear that this group of teachers was as willing to take advice and help as they were to provide it to others. This was a contributing factor to the design and implementation of ongoing support throughout the fall semester.

4.2.4 Professional Development – Professional Learning

While the previous sections focused on themes that emerged from the professional development, this section is dedicated to one of the most important aspects of the professional development, the schedule and layout of the experience, and how it was received by the participating teachers. Subcategories for this topic include focus points, student and faculty panels, navigating course content, overview of assignments, hands-on experience, delivering grades and feedback, things to improve, things we are doing well, and unanswered questions.

Focus Points

As ‘design thinking’ is not a common concept for high school teachers, teaching a semester long Design Thinking in Technology course could prove to be difficult. The researchers, therefore, emphasized concrete examples of design thinking as reference points throughout the professional development. When trying to describe the impact of design thinking, one researcher summarized:

A great example of this is Bank of America's Keep the Change program. Building on a common savings habit of tossing change into the jar. Bank of America created a program in which it automatically rounded up debit card purchases to the nearest dollar, and transfer the difference into the customer savings account. This creative goodwill approach spawned more than 700,000 new checking accounts and 1 million new savings accounts in its first year. A perfect example of how design thinking converts need into demand.

Researchers also emphasized that the delivery of the class should reflect design thinking. “Design thinking encourages experimentation and accepts there is nothing wrong with failure as long as it happens early and becomes a source of learning.” While this is true for students as they move through their projects, it is also reflected in the way that students first submit their assignments to their teachers for feedback before submitting revised assignments for college credit. This also led to the introduction of the term ‘pivots.’ Pivots are roadblocks in a project where to continue moving forward, a student must first change direction. Note the number of times the researcher emphasized the term ‘pivot’ in the following quote:

Talking about **pivots**. So, I'm imagining if I used [language from the video] here, each of these meetings might actually be a little bit of a **pivot**. Because we've got it. We've finished meeting five, we're going to head out into the, the construction lab and see what kind of problems might exist because we suspect there's going to be something we go and we look and we actually begin to **pivot** because that what we didn't find what we thought we'd find we found something else. Now again, just look for some literature to help us either **pivot** again or confirm the direction we're headed.

While students having to change plans can seem frustrating, researchers made clear that pivots are not only to be expected, but that they are something to embrace. It was common to hear such phrases as “That example was so good because of the pivoting they did.” Or “Pivoting is a success, not a failure.” They even encouraged teachers to “Comment on your pivot.” Even though researchers encouraged pivots, they acknowledged that they are difficult. “But you know, really, the pivot is hard. The pivot is you just hit a dead end and you've got to change completely. But it just seemed so natural.” Or “The pivot sounds so nice, but really, it was like we're heading down the wrong road, and we swerve, and we go a different direction. I think that's a really important part to notice.”

Misconceptions about prototypes were also addressed. Often prototyping implies a physical product, especially if teachers have a background in engineering and technology curriculum. It was therefore emphasized “Prototypes need to be testable, but they do not need to be physical. Storyboards, scenarios, movies, and even improvised acting can produce highly successful prototypes.” One contradictory message was addressed, that there is nothing wrong with failure, but students are also expected to create a working prototype by the end of the course. A researcher explained that the intention of having a working prototype is to push students to ground their solutions in reality, not to penalize them if it does not work:

Right now the push that we're kind of thinking in our minds is that we want to push the students into having a functional prototype. This thing actually has to work. Now, you know, we don't want the students to fail if it doesn't work, and we want to be a little bit gentle there, but pushing them into reality helps to narrow down some pieces without them.

Talk about prototypes and products prompted some teachers to ask what the focus should be for students. Should students be primed to solve a problem that is given to them, or should they be innovative in seeing problems that others don't see? One researcher responded that both are appropriate mindsets for the course with an analogy:

Sometimes my boss gives me a problem and says, solve it. And I've got to go out and figure it out. Other times, I see an opportunity, and I say, you know what? I can do something here that's very unique. And the way we engage in those two different kinds of approaches don't necessarily conflict, but they're appropriate at different times. So this might be a good learning opportunity for the students to think about those two different approaches.

Another researcher noted an example of non-physical prototypes from a different video clip shown to the teachers about how a hospital made a small change to improve interactions:

The nurse knowledge exchange, with exchanging information in front of the patient instead of in private. So that comes from listening to see what are people needing, and what do they want to get? What do they need? Why do they need it? How did you find that? And that's where we kind of transition into the observations, and the interviews, and just building that empathy for the person.

Observations, interviews, and building empathy are all major components of the design thinking course and the student experience. By providing teachers with concrete examples of their application, they are better equipped to provide relevance to their students.

One common misconception with students in Tech 120 is the importance of quizzes. Quizzes are implemented frequently throughout the course, but the intention of the quiz is largely as a tool for discussion, and have very little impact on a student's grade. Because this has proven to be uncommon, researchers explained:

I'd like to make two comments about the purpose of those quizzes. One is that they're intended to be some tough kinds of questions to remind the students of why they went through the reading. And they're also to a certain extent, a little bit controversial like that second question that 5 had us answer about what kind of mindset if the student hadn't read and did not read the material, that was a really tough question... So we think of those as a mechanism to motivate or hold students accountable for engaging in the material. So it's kind of reading

compliance, but then it's also a discussion, launching point for the beginning of class.

Teachers were also empowered to embrace design thinking in their approach to the course. It was noted that while each day has a lesson plan and carefully selected assignments, it is a result of gradual modification over time:

Some of it I've authored and others has been contributed by [graduate students] having just great ideas and saying, 'Hey, you know what? It'd be a little bit smoother if we had a forum here. If we modified this or what about this other article or video that we found?' So what you're looking at is a compilation of really eight years of evolution.

It was encouraged that teachers be reflective about their experience in the fall and provide input and feedback into continuing to evolve the course. Later the researcher made it clear, stating "I'm very interested in empowering all [the instructors] to notice something and say, 'Okay, how could we make it better?'" This is not to say that teachers were only encouraged to make suggestions for future modifications, as the researcher went on to acknowledge that the teachers know their own students best:

I would love to say that I've got the pathway exactly figured out, it's paved, and you can't go off the bumpers. But the reality is, you know, we're still learning. There are a variety of approaches, and what works for us at the college level may be very different from what works for you at the high school level. So if you've got to take a different path, but you end up with the same result. That's awesome. And I think we can learn from each other that way.

Modifications, scaffolding, substitutions, and supports were all allowed and encouraged so long as teachers "focus on the syllabus, focus on the big idea, and then focus on meeting those rubric items in each assignment."

Student and Faculty Panels

Throughout the professional development, the research team put together a number of panels related to the curriculum for the teachers to interact with. This included meeting with the dean from the Polytechnic Institute, Tech 120 alumni, other instructors in the polytechnic, a recruitment panel.

In the alumni panel, past students were encouraged to share their course experience and the opportunities it provided them. Teachers were provided an opportunity to engage these Tech 120 alumni in a discussion about how their final design projects impacted both their internships and work experiences after the course. One student shared how their final project drew the attention of a local technology company and helped to establish an internship. Another student shared that they were now a co-inventor of a patent pending spoon for those that struggle with Parkinson's.

A third alumni shared that they are now employed by a major aviation company. They went on to describe how they manage customer business requirements, daily analytical and automation products. The solutions that their team creates daily are all related to infrastructure performance engineering across the company. They shared how much they value their agency from Purdue, and especially their degree, noting that about a year into working for the company, a course came up internally called 'Design Thinking.' The coursework provided by the company was very similar to Tech 120: Design Thinking in Technology, lending both justification and credibility to the Purdue curriculum.

This selection of students from those that recently finished the course, to senior year patenting a product, to working for major companies provided teachers with a big-picture view of the intent of the curriculum. Teachers asked many questions throughout this panel as they reflected on their own students, such as "I was curious how this class, Tech 120, overlaps or the differences between some of the things you experienced in high school design? Was there anything that stood out as different that sort of took it to the next level?" Another teacher wanting to anticipate scaffolding inquired "What were some of the things that you guys, either as yourselves or your peers struggled with the most when taking Tech 120, like, what was most confusing what was hardest?" A third teacher looking for ways to help the curriculum stand out asked "Is there anything we can do to help our students recognize when to pivot? We've done some things with our students in the past, and they really want to hold on to ideas sometimes." Another teacher reflecting on their teaching style asked "What were some coaching techniques or tricks that some of your instructors use that you found helpful?"

After the panel left, the teachers reflected "I really liked that panel and seeing, you know, from their perspective since they had taken the class." Another teacher, reflecting on responses to questions noted "They gave a really, really good insight." A third teacher offered "I think my big

takeaway was just how excited they were about what they learned and what they and how they were able to apply that. Like that spoke volumes to me.” Perhaps the most impactful comment was “I think I would definitely like to start out classes with people like that, to give students an idea of, of this has value.” As this resulted in a curriculum change, integrating video clips of student and industry insights into prep work for not only the high school, but the college level course as well.

As Tech 120 is a core Polytechnic required course for thirty-five (35) different majors, a five-person faculty panel was assembled to share what design thinking in their fields looks like. The faculty were selected to represent not only popular fields of study, but many fields that students initially struggle with making the connection to design thinking, including Engineering Technology, Biometrics, Construction Management, UX (User Experience), and Information Technology.

Panelists shared insights into things such as how design thinking is not always about a product, “A lot of our students also work on the process side of the house, and so it's just as important to know who the end user is of a process and how that impacts of course the product.” Another shared how design thinking helps make sense of open ended problems “So specifically, a lot of what our students are trying to tackle are really messy, complicated problems that have to do with human behavior as people use technology in a really broad sense.” Many panelists reflected how important the course is as a building block for future courses “Design thinking is embedded in our curriculum as well, not only in the degree programs in ETTE (Engineering and Technology Teacher Education) but also in the design innovation minor, as well as organizational leadership, and Human Resource Development as well.” In stressing the importance of design thinking, one panelist made similar comments to the student panelist “Design thinking is embedded, ingrained, in our majors. It's just a constant cycle that our students go through and come back and talk about it as alumni, how having that structure for the design process really makes their job easier.” Another panelist addressed how design thinking has led to new uses of technology in the construction industry “So there is a lot of new technology in augmented reality. People are using more of that, for example, for safety training. How do you develop products, how to incorporate robots into the jobsite?”

As before with the student panel, teachers were given the opportunity to ask questions, this time largely focusing on instructional strategies. Panelists came back to the idea of pivots

and shared how struggle is a good thing “Teach them that it's okay to fail. Not grades, but it's hard. It's hard to come up with a solution. It's hard to identify the problem. I think sometimes they're afraid they're gonna trip up so they won't even try.” Another panelist reflected on how design should be an iterative process “Getting our students to not think about design as a series of steps is one of our biggest challenges.” A third panelist focused on getting students to think creatively by forcing the pivot, “Add a constraint that would then cause their solution, proposed solution, to fail so it won't work. So you add a constraint and say, ‘Oh, well, you know, that won't work because whatever’, and then they have to shift gears.”

Teachers expressed gratitude to the panelists and reflected on the insights they would be able to take back to share with students interested in different fields of technology, and strategies for teaching design thinking concepts. It was a goal of the research team for teachers as facilitators of the Tech 120 curriculum to be clear that students are not earning credit for an elective course, but for a core polytechnic requirement that is valued both across the Polytechnic Institute, and as a professional in the field. From the teachers’ responses and reception, it would appear that this goal was met.

Navigating Course Content

Course content for the Tech 120 curriculum is hosted in two documents, a student version that contains all prep work, assignments, and rubrics, and a facilitation guide with lesson plans, suggested in-class activities, and notes on instruction. It was therefore important during the professional development to help navigate where to look for various materials, and how to effectively switch between the two documents for daily lessons. Teachers were given a lesson to present as part of the professional development, and while investigating the content, conversations of where to find content were common and encouraged. As an example one teacher mentioned, “Okay. I thought I just went to [lesson] seven, and so I went to seven, and I'm like, there's not enough information for me to teach in here.”. The researcher responded:

Well, you're going to assume that they already did [the prep work] both one and two. So they have completed the research assignment, and they've watched that video, and so where you should be going for content for teaching is not this document. It's going to be in the Implementation Plan. That big Google...

This kind of question was asked by multiple teachers throughout the workshop, as seen again here by a different teacher. “So to my understanding, I should primarily be using the Implementation Plan document to pull the like content and plan my lesson. Is that correct? Because I see what's in Brightspace, and it has more of the student facing content.”

Researchers noted that as teachers would have weekly communication with the university, they did not need to become experts in the course by the end of the week “We'd like to provide you with just enough background experience, just enough onboarding to what we're doing here that you can ask the kind of questions [others] asked, and so you understand a little bit of our system.” The researcher continued to emphasize the goal of building trust and a community so teachers would feel comfortable helping one another throughout the school year “We hope to build a sense of community, and we talked about this earlier this morning, a couple of you had mentioned, the idea of trust.”

Teachers not only navigated the curriculum as instructors, they also navigated what it would look like as students. While the LMS offered some functionality for a ‘Student view’, it was not a representative view of what the students would experience. To remedy this, one researcher created demo student accounts and shared the importance of helping students navigate the program:

We want you to be able to use Brightspace, both as an instructor and as a student, and so we had the university create a couple of demo student accounts. So this is going to let you see what your students see what it looks like to turn in assignments. [It will also show] what it looks like when they receive feedback, both on the rubric, and how your typed comments appear to them. So you have access to that experience now, and you can use that to help them in the fall.

This time spent helping teachers navigate curriculum was noted and appreciated, as one teacher reflected “I just appreciate how understanding you guys were when we may not have been on the right link. We all tried our best to be prepared, there's just a lot of new onboarding stuff. You guys are just really patient.” After some time applying the curriculum in the creation of lessons, teachers seemed confident in navigating between the two documents, and better prepared for the upcoming school year.

Overview of Assignments

Researchers made a concerted effort to put lesson in context of both the unit and course throughout the professional development. On the first day, one researcher explained:

As we look at our number of meetings, we have, roughly a 16-week semester, which ends up to be about 15 usable weeks between the breaks and those kinds of things, and finals week. Based on a meeting pattern of 15 weeks, we have roughly two meetings per week. So we have almost 30 meetings, but there's usually a holiday in there that cuts at least one. So we've planned for 29 meetings, and those 29 meetings are listed here [in Brightspace], and we roughly break the course up into three projects.

Length and purpose of each project was explained, as were key lessons and assignments that students would see repeated throughout the semester. De-identified student journals and assignments were provided to not only help to calibrate teachers on course expectations, but to have a better idea of what students would be tasked to do throughout the semester. The researchers provided time for teachers to explore student work in the context of their design journal, a document that contained all of the preparatory work and in-class assignments for the final project:

So I'm going to give maybe 15 minutes or so to take a look at their design journal, take a look at the rubrics and see how you would grade it and what kind of feedback you would leave them. If you finish early, feel free to look through and see what was their final solution? How did they test it? What kinds of things were they testing?

Teachers were very receptive to the exemplars, noting what kinds of scaffolding they may need to support their students. One teacher reflected “You know, looking at the observations that I was looking at on here, how would I talk them through that?” Another teacher remarked “Wow. Oh, this is Great. Okay, so that's what I want. That's what I want them to do something like that.” Teachers were also given the opportunity to complete shortened versions of the assignments as preparation for selected lessons that they would practice teaching as part of the professional development. After seeing the course overview and hearing from panels of students and faculty, teachers expressed some enthusiasm about completing these assignments. One reflected on the impact of some of the articles “Just the importance that the articles placed on

actually interviewing real life people really stuck out to me about empathizing.” Another teacher was very excited about bringing the content back to their school, sharing:

I spent last night, you know, doing the pre stuff, and reading the articles, and it made me realize just how much more I think we can do as a school, like, to bring design thinking in, and so I'm super stoked about all of this!

Assignments that were particularly difficult to students to interpret or for teachers to grade were also chosen to share with the teachers. To highlight one example, a researcher had three different teachers grade three separate assignments before pointing out:

So I know for me, this is a trickier assignment to grade, because it's trying to balance between three separate assignments into one rubric. And so I just wanted to kind of let you know ahead of time that this is something that is in the curriculum now. That it is one of those trickier things and why it's so difficult to kind of give them just one grade for three separate things.

In summary, teachers were provided with a broad course overview, details about each of the projects, exemplars from key assignments, and context about key lessons. They were also provided assignments to participate in and talked through assignments that are often challenging. The next two sections will explore further the depth of the hands-on experience and calibrating student feedback on sample assignments.

Hands-on Experience

Before the workshop even started, teachers were tasked with completing a guided, fast-paced design project that would provide context for the lessons they would be teaching throughout the week. On the first day, to help prepare teachers for their lessons, one researcher modeled a lesson based on the context of the previously completed design project. Teachers were assigned group work and prompted to use the LMS to submit their assignment, both for the experience of navigating the system and for finding student feedback. The researcher explained:

So whatever you guys turn into me, I am going to use this rubric to kind of assign you some points to it. And then some feedback as to what I was looking for if there's any miscommunication just so you can see as students, what does that look like to receive that? And how to navigate the rubrics, and the grades, and the feedback so you can see that process.

The researcher then narrated the process of preparing for the lesson, showing where material could be found between the teaching document and the LMS. Teachers were encouraged to approach their lesson presentations as if it were their own classroom, knowing that the audience would be supportive and offer feedback to help adjust and refine the delivery.

However you engage us tomorrow, think of that as practice trying our lessons, and really kind of a prototype for how you might introduce that to your students in the future. And what you do tomorrow will probably look a little different than what you do in the fall and that's okay, because, you know, we are on our side.

Before each teacher presented their topic, one researcher took the lead to set the context and expectation for the lesson:

And so what we'd like to do in the next little bit here is [teacher], you're going to share with us lesson three. And you're going to make some assumptions that we've read through the material, that we've taken a look at whatever preparatory material there was. Maybe you could refresh our minds on what we did before we came for homework, and then you'll engage us in some kind of in class experience. And, you know, if you've got questions along the way about how we do it, we could either have kind of a live discussion while you're teaching, or you could save that to the end and we can have a discussion about differences between your approach and our approach. Either way is fine.

Teachers did very well with adapting the lessons to match their teaching style, with slides and stories. During one lesson a teacher offered “The design process is, remember human centered. We're designing it for someone. So I actually want to interlude it with a brief story. So this is like a classic game, if you don't know this game it's called Guess Who...” Many teachers worked in pieces of interaction that utilized the online format. As an example, one teacher prompted:

We're going to kind of do some comparing and contrasting. So I'll read actually two POV statements. When I'm done, I'm going to give us like a 10, maybe a five second countdown, and then I'm actually going to ask if you could type in the chat, which number you think is better.


Another teacher used Google Slides as a digital gallery walk where each person was assigned a slide to complete, and after a set amount of time all were encouraged to read and

leave comments on each other's slides (see Figures 14 and 15), while other teachers used Google Hangouts for Venn Diagrams and organizing brainstorming sessions (see Figures 16 and 17).

Group Sharing Slides

Instructions Link

Video for Reference



Criteria for a POV Statement

- Provides focus, but enables "How might we" questions
- Is actionable
- Saves you from the impossible task of developing concepts that are all things to all people
- Is a concise, one-sentence statement
- Does not have an embedded solution in it
- Has clear user, need, and insight**

Structure for writing a POV statement

USER

+

NEED

+


INSIGHT

Descriptive Verb/ action Compelling

POV 1 - Suren is in ICU 7,000 miles away from home. He has no health insurance to help him with his medical bills while being hospitalized, and has no familiar social support. He needs a way to connect to family and afford his bills.

POV 2 - Suren was in a car accident while visiting the US for a conference and woke up in the ICU. He does not know what happened and is struggling to understand what doctors are telling him due to his English not being fluent yet.


POV 3 - Suren needs medical care and has been waiting in a bed with an ventilator for 3 days. He has not been prioritized by nurses and doctors around him due to implicit biases and stigmas. Hospital systems and the employees within them.



POV 1 - Chris needs a way to stay updated on his wife's post-surgery status so that he can feel secure enough to rest and know when to return to support her.

POV 2 - Chris needs a way to rest while supporting his wife post-surgery because his commute to and from the hospital is very long and driving makes him even more exhausted.

POV 3 - Chris needs help to balance caring for his wife and self-care as he is overwhelmed and struggles with how to do both.



POV 1 - Charlie needs someone to talk to him about payment options/solutions.

POV 2 - Charlie needs to be able to focus on healing so he is back to work quicker.

POV 3 - Charlie needs someone to talk to help him process his situation.

POV 1 - Patients receiving potentially life threatening results need a tangible, comprehensive method of suggested treatments because they are often too shocked to understand their treatment options.

POV 2 - Patients receiving treatment options need a method that can be referred to later because they are often too shocked to understand options

POV 3 - Patients receiving results from tests often need a way to process the results prior to treatment options because they are often too shocked to deal with treatment.




Figure 14. *Digital Gallery Walk*

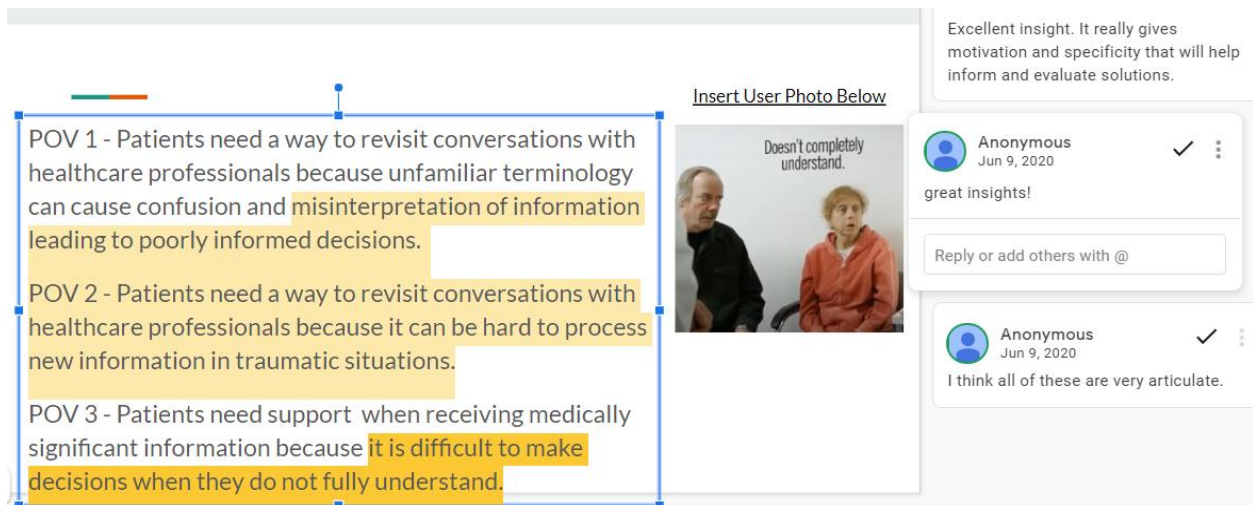


Figure 15. Digital Gallery Walk Comments

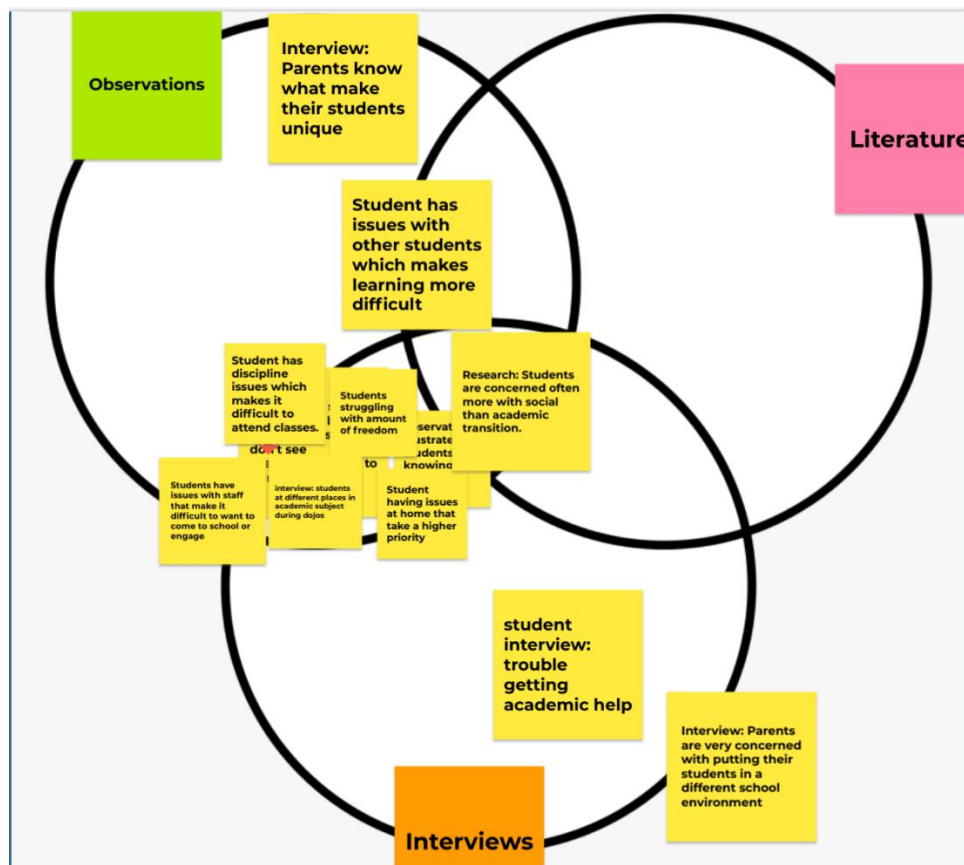


Figure 16. Google Jamboard Venn Diagram



Figure 17. *Google Jamboard Brainstorming*

As previously noted, teachers were encouraged to complete preparatory work each evening for the next day's set of lessons. While the content remained similar to what students would experience, the requirements were modified such that teachers could complete the assignment in a shorter time frame. The original instructions were preserved and presented as a strikethrough for teachers to compare (see Figure 18).

Modified PL Assignment

As a modification for this summer professional learning, recall a conversation you had with someone about students transitioning to your school. Was it a parent? Student? Faculty? What insights do you have as a result of that conversation?

- What did you learn? What do you still need to know? What does the information mean? Is it valid? If so, why? If not, then what? How does this inform your design process?

Please fill out [this modified template](#) and submit for the 'Before Class' work for Wednesday.

Notice the rubric before submitting.

Research: Ethnographic Interviews

Student Assignment

As part of the Meeting 7 In-Class exercise, you identified stakeholders. Your individual responsibility is to conduct ethnographic interviews with 2 members of your designated stakeholder group. As is standard practice in ethnographic research, interviews need to be recorded to allow easy reference (as well as establish/maintain researcher credibility).

[Ethnographic Interview Template](#)—Make a copy in your Drive. Download as a PDF (File → Download as → PDF) to submit.

Instructions, Specifications, and Hints:

- 2 different stakeholders, related to your problem, need to be interviewed
 - you may NOT interview yourself
 - you may NOT interview a member of your group
- As both videos point out, ethnographic interviews are as much about observation as verbal questions
 - interviews should be conducted face-to-face
 - Only 1 interview may be conducted as an interview via email, phone, etc. You will need to provide proof that this interview took place.

Figure 18. *Modified Assignment for Professional Learning*

As shown above, teachers were engaged active participants throughout the week in immersive professional development opportunities. Teachers utilized curriculum material to create their own lesson plans, and discovered new methods and limitations to engaging students on an online platform. While the format of the school year was uncertain at the time of the professional development, this became more valuable as schools shifted schedules and limited face-to-face classes to maintain social distancing.

Delivering Grades and Feedback

While students enrolled in Tech 120: Design Thinking in Technology for dual credit were assessed by an instructor of record from the university, teacher alignment on assignment expectations remained a priority. Teachers would not only provide the initial instruction, but they would set the expectations for student work, and provide valuable feedback that would allow students to strengthen their assignments before submitting for college credit.

Teachers were initially concerned about ambiguity in assignment expectations, especially as much of the work students would be completing centers around open-ended design problems. One teacher went on to share their concerns based on past experience:

You know, math is just right or wrong, where something creative can be more subjective. You know? What's desirable maybe to one person, maybe isn't to somebody else. Just, I'd like very clear guidelines. Sometimes the rubrics have so much leeway in them. My best example is I was with one of our teachers, and we were watching final pitches [for a design competition], and he was giving what we had at the time was a gold. And I was like almost looking at approaching you know, or bronze or whatever. We were so far off because the rubrics allowed that much leeway. So that's all, I'm looking for something more, more definitive.

To help address the concerns of grading expectations in the Tech 120: Design Thinking in Technology curriculum, it was made clear that every assignment has a detailed rubric, with clear expectations for full points, partial points, or no points. To check for interrater reliability, an activity was designed to have both the teachers and the researcher evaluate de-identified student work using rubrics from the curriculum. One researcher explained the procedure:

I'm going to show a design journal, share design journal with you, that's been de-identified. And we're going to go through and give actual ratings using rubrics. This time I'm going to have you actually look at content that a student has submitted, so it's not a peer, and practice how would you grade that as an instructor. Let's just kind of calibrate and see if we're all on the same page, because I think, [teacher name], you mentioned that when you have used rubrics, and it's something like this, it can be seen as subjective, that people may challenge, the point value on those. And I'm curious to see how much

differentiation there would be, and how others may see it differently with this small group.

As the focus of the exercise was a discussion on expectations and feedback and not on navigating the LMS, a set of Google Slides were created to better visualize and share findings. Teachers were encouraged to move an “X” image to the appropriate box, and give their justification as to why they felt the student earned that score (see Figure19).

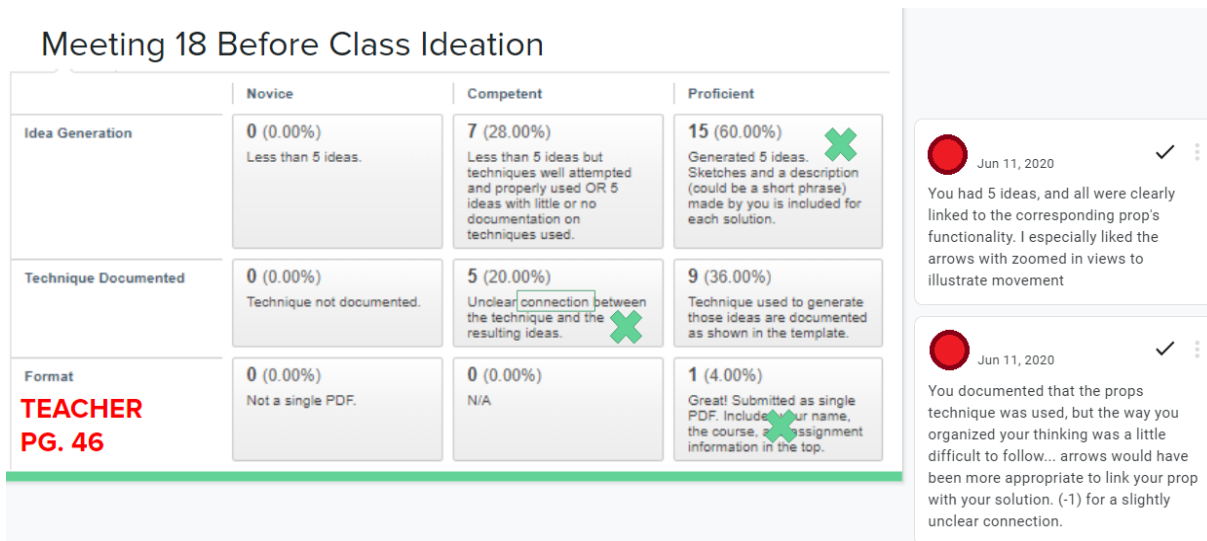


Figure 19. *Rubric Practice Activity*

As teachers talked through their strategies for deciding on the most appropriate grade for each student, one teacher noted that some of their peers shifted the “X” more to the right or left to indicate partial points “I really like that you kind of chose between some of these columns here!” This prompted another teacher to acknowledge “That's a good idea! I didn't know you could do that. I can replicate that. I can do that.” The researchers acknowledged that when following the rubrics to grade student assignments, it is common to give partial points. As students may be upset at not receiving full points on assignments, one researcher provided a strategy:

I think that's a really good point, about going between [criteria]. And so our strategy for going between them is to mark the lower value in the rubric, and then override to the higher value, because if we mark the higher value and we override

to a lower value, then the students want to argue about it. So procedurally, that's a little bit easier for us.

Another researcher shared expectations on the quality of feedback, noting “I like to give feedback if I'm marking anything less than perfect. So if I marked down two and a half here, I'd want to add some feedback as to why. I make sure to type in a little something.”

After talking through assignment expectations and coming to a consensus on student work, another activity was introduced to focus on using the grading system within Brightspace, Purdue's LMS. Throughout the week, teachers either took the lead on teaching lessons or acting as students and completing prep work and in-class work. When acting as students, the work was submitted as a PDF file through Brightspace. After all lessons were finished, teachers were tasked with going back into Brightspace as instructors to explore how to use the various available feedback features. Some troubleshooting was required, as noted by one researcher:

Last night, I issued the challenge of submitting an assignment as a student and then going back and grading an assignment as a teacher of that course, and I see that everyone was able to, or it looks like everyone was able to submit as a student, is that correct? Okay, but then when I look at how many were able to grade as an instructor, looks like just two of you were able to do that. So I wonder where there's some problems you ran into along the way, maybe with switching between accounts, maybe you didn't have access to that or couldn't find the right features.

For some teachers it seemed that work was not turned into the correct location or someone else grading their assignment. One teacher pointed out:

For me when I went in to grade, the only assignments that were submitted for my category to grade were the pre coursework so there wasn't the end classwork submitted, and then when I graded it this morning after I submitted it, I saw that somebody else had already graded it.

Another teacher found that there was an assignment, but not the one they had expected “For me, what was assigned What was turned in was not for my course. I was looking at it going, ‘this is a Venn diagram, and we didn't even have that as an assignment!’” While another teacher wasn't sure where to start “I'm looking at it again and I'm just kind of lost to be honest.”

The researcher summarized the difficulties experienced by the teachers and asked one that had some success to re-trace their steps:

So, I'd like to try a couple of things here. It sounds like [teacher A], you may feel a little bit lost. [Teacher B], it sounds like something happened and you're not quite sure why it doesn't show that it's graded. And [teacher C], I see that you're having trouble with just your, your connection. You're losing the audio and turn off the video and that's, that's okay. I wonder if I could have maybe [teacher D] and [teacher E], if you could kind of model what you went through to get to that assignment. And what that looks like for you to submit. So [teacher D], I know you didn't grade yours but sounds like you found it, and you saw how you could have graded. It might be most beneficial to go to yours. Would you be okay with modeling that?

As the teacher went back through their process of opening and marking assignments, they focused on tools they found most helpful. "I really like the comment and highlight features in the grading system. That was really great. And it allowed me to give better feedback and comment on the certain pieces of the assignment."

The researcher was also able to troubleshoot some of the sticking points for teachers, drawing attention to important student-to-teacher communication tools.

Researcher: You have a comment from your student. Did you see that there?

Teacher: I did not.

Researcher: On the left hand side.

Teacher: Oh! (*reads comment out loud*) 'I don't think this has anything to do with your lesson. Sorry!' Okay, no, I didn't see that!

Researcher: So that's a good thing to point out. When your students turn things in. They'll have the option of adding little tag lines like this on top of the attachment.

As the session went on and more teachers interacted with the various tools, they gained confidence in navigating the software. The teacher who was lost before starting the troubleshooting session noted "So now that I figured this out, I really like it!" After all teachers successfully gave feedback, they switched back to their student accounts to see where they would need to navigate to read it. Again, the researcher asked a teacher to model their steps in

viewing this material “Okay, so let's go back to your homepage and walk us through. How did you get to that assignment? Because this is going to be something that students will really want to know is how do they get their feedback.” As one teacher shared where they went to find information, another noticed that it was in more than one location “Can I tell you there's another way to do it? At least from the student view that I did. I went to grades, and went down to the assignment.” A third teacher commented “Mine looks totally different from that. Maybe I went to something other than grades? Let me go back.”

Toward the end of the session, the researcher prompted, “Is there any feedback or questions you have for submitting assignments? Do you all feel like you could walk students through that process and are you comfortable with what that looks like?” After confirming with all of the teachers, the researcher asked again, “Okay, and then from the instructor side of things, do you feel comfortable with giving feedback to students using the rubrics, using the different tools, to go through and let them know how they did?” All teachers again confirmed that they successfully used tools to provide feedback to students. The researcher asked a final time “And then once more from the student side of things do you feel comfortable with showing them how to look at their feedback and interpret it?” Again, all teachers confirmed that they would be able to help students navigate the gradebook.

By the end of the workshop, teachers had reached a consensus on the expectations for student assignments, successfully navigated the program they would be utilizing to administer feedback to students, and were able to both submit work and find comments and feedback in the student view of the software. While there were questions throughout the process, teachers expressed confidence in the process, noting that it would be easier with more practice. As with all of the events from the workshop, these help sessions were recorded and remained accessible throughout the summer and fall.

Things to Improve

While the workshop was successful, there were noted areas of improvement that emerged from individual interviews. Some items could be immediately acted on in preparation for the fall, while other items of concern would only be relevant for the next iteration of the professional development.

One such item for future consideration is the start date of the workshop. Researchers had selected dates that the participating schools typically used for professional development, not realizing that final grades were due the night before the first session. In addition, to make the most of the teachers' time throughout the week, a mini-project requiring teachers to interview someone from the other participating school was assigned to be completed before the workshop. Teachers expressed heightened anxiety and stress resulting in a lack of focus for the first day of the workshop. In addition, one teacher seemed unclear on the purpose of the assignment, stating "I didn't realize that our POV statement we worked on before we got here was what we were going to work on all week."

The topic of the mini-project also proved to be problematic for many teachers. Researchers chose the prompt, "How might we better transition new students into [your school]?" The intention of the question was to find common ground for participants to use throughout the week, while also sharing useful information of both successful and unsuccessful strategies. One teacher noted that this added to their stress "I guess it you know, it honestly, it became sort of stressful, like dealing with all of the problems of my job while being here as a problem statement." Another teacher seemed frustrated, noting "I don't get to do anything with it." They went on to elaborate "I would love to go back and say, This is why we need to change this. But I don't feel like I have the authority to do that. Because that's not why I did this training." Another teacher had similar views:

We don't have set systems and honestly every year introducing students to it has been different. I know that people are working on the transition piece. I know we have lots of voices in it, and I kinda was like, well, whatever we come up with isn't gonna be implemented this fall anyways, because we have too many other things going on, and because there's already people making those choices, so maybe I felt disempowered.

Some teachers did not take issue with the prompt, but had difficulty in conducting the interviews as they felt they already had too strong of an opinion. One teacher reflected "I almost had a viewpoint on it already. It was hard to be naive. As we said that one time we want the naive mentality, right? Asking questions. So for me, that was hard." Another teacher shared a very similar comment:

I thought that the question was fine. And the topic was fine. I think it was, like the part that was trickiest, was that I'm trying to step outside of seeing, okay, my user. Like, I'm also technically a user if I'm designing for teachers. And so separating my own biases from what my user was sharing was challenging, because I could really relate to all of it.

Another area of concern was in the organization of curricular documents used to facilitate the course. On campus, instructors utilize both Brightspace, the university's learning management system where the student side of curriculum and materials is hosted, and an Implementation Plan that is a 'live' document, containing lesson plan information and notes from weekly meetings. One teacher found it difficult to see through the strike throughs and meeting notes reflecting, "I think that the [Implementation Plan] was, you know, a little bit, you could tell it was built by teachers kind of planning on the fly along the way, adding things taking things out." Another teacher found it helpful but initially unclear, suggesting:

So that part, I think, was a little confusing. From the user experience standpoint, having clear separation would probably help with that in the future of like, here's stuff for the instructor to know and think about, and then here's the stuff that we actually would like for you to make sure gets out when you're teaching.

While researchers did provide demonstrations on navigating between the Implementation Plan and the student content, it occurred toward the end of the first day when teachers may have been overwhelmed with new information. This was echoed at the end of the workshop, as a comment from one teacher indicated they were unaware that instruction on this was provided:

I think in the future, it might really help to walk the staff through how the Implementation Plan pages are set up, like where it says the big idea label and reflective questions and just kind of talking through how that is set up and what the mindset and thoughts are behind each section.

It should be noted that while researchers were available for questions as teachers reviewed content for their lessons, there was not structured time provided for them to find specific information.

Some comments from teachers were not reflective of topics that were provided, but rather ones that could be included. Multiple teachers expressed interest in seeing what an on-campus class looks like, how the instructor interacts with the students, and how much time is spent

teacher-led compared to student-led. One teacher commented, “I would have loved to see even just some clips of classroom at the college level and how the class is sort of set up and how the dialogues flow there.” Another teacher shared a similar remark while reflecting on the impact of online teaching:

[If we] observed the class with the college students a couple times, it might have helped me understand the pacing, especially because now we're in this digital environment and everything gets a little bit off pace or differently paced because of technology.

Another theme for improving future professional development experiences was to provide more clarity and transparency leading up to the workshop. Researchers had decided to send the following emails at strategic times to participating teachers:

7 weeks prior: Registration for a Purdue Email account, access to curriculum

2 weeks prior: Survey with IRB release form

1 week prior: Mini-project interviewing another teacher

1 week prior: Login information for Microsoft Teams, access to PD schedule

Follow-up emails were only sent as needed if it looked like we were missing information for any one teacher, but this method resulted in some questioning if they had completed all the necessary tasks. One teacher shared they would have felt better with a document of tasks to be completed so they would know they had provided everything necessary “A checklist would be great. When onboarding with all the different things to get logged in accounts, like if that's on a one pager.” Another teacher noted they had not anticipated the workload involved for the week:

Maybe a communicating ahead of time that there may be lessons to review outside of the PD time, and that you'll be preparing the lesson or like for everyone to get used to the material and give feedback to you on how it was executed and what went well. It was fine that we didn't have that. But I think it might be helpful for some people that are more of planners where they're like, okay, I need to make sure I'm free this evening because tomorrow I'm going to have a presentation to do so I need to have time to put it together tonight. So I was glad [someone]

volunteered to go first, because that Monday night I already had plans of things to do, and I wouldn't have had time to prep for it.

After nearly forty hours of professional development, teachers felt comfortable sharing not only areas that could be strengthened, but also suggested content to include. Teachers overall expressed positive experiences and genuine interest in helping to shape future professional developments.

University and Secondary Overlap

Throughout the week, researchers and teachers navigated similarities and differences to identify where extra supports may be needed to bring students up to the appropriate level, and where lessons may need modifications for risk of being too redundant given the students' entry level knowledge. One teacher was quick to point out that students may be too confident "Just because you know how to follow the steps does not mean you know how to think it. I think that's gonna be the hardest part for them, but I think this class will really guide them through that."

Another teacher noticed similarities with the final project in Tech 120 and design projects that students were already familiar with as part of other high school courses. Seeing that the final project is a considerable portion of the students' grades, and encompasses nine (9) weeks of the course, the teacher asked:

What's different about what our students have already been doing and what they need to be doing in Tech 120? I'd love to maybe dive into that a little more of like, what are the what are the must haves in the final presentation?

Researchers addressed this by providing structured time to review rubrics and de-identified student design journals containing all their classwork from the final project. They also provided the teachers with a Venn diagram that was populated each day throughout the week to keep track of similarities and difference between the university and high school (see Figure 20). Similarities included group work, documentation in some form of notebook, and presentations of the final project, while differences included homework expectations, depth of the design experience, and accountability through grades, credit, and tuition fees.

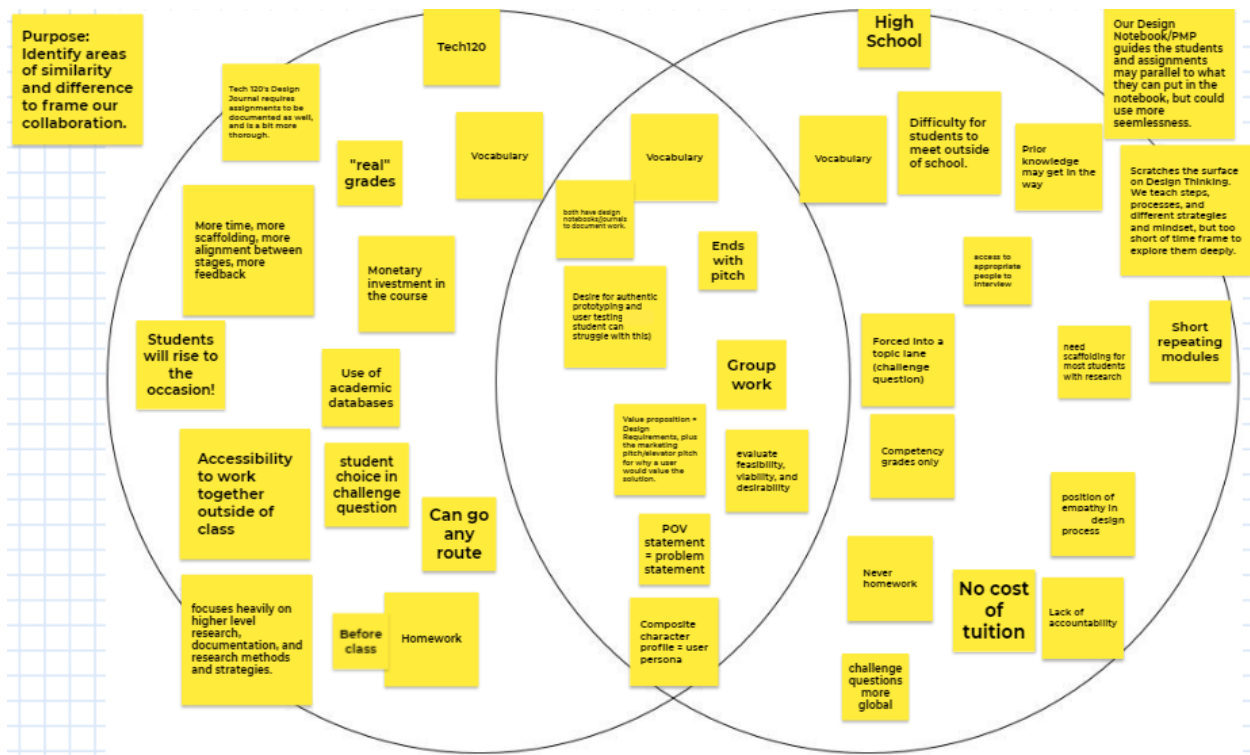


Figure 20. Venn Diagram Comparison of High School and College Design Courses

Partway through the week, one teacher realized how much was being added to the Venn diagram, and remarked:

I don't know what our Venn diagram will end up looking like, but I do think it'd be necessary to maybe make a second one as colleagues here, for comparing and contrasting the way that we grade, and what we've been looking for in our presentations versus Tech 120.

While a second diagram was not physically created, a significant amount of time was spent aligning grading practices and identifying expectations to conceptualize these concerns. In addition, KWL charts were used each morning to address some topics that teachers wanted to know more about, and an 'Implementation Parking Lot' was added to identify questions to resolve or work through by the end of the week (see Figure 20).

Workshop Highlights

Throughout the workshop and during individual interviews, teachers noted parts of the planning and scheduled activities that they appreciated. Themes include early communication, workshop structure, hands-on activities, and course content.

While it was noted that the lack of a checklist and multiple emails resulted in some confusion leading up to the first day of the workshop, teachers who had experience with other professional development workshops appreciated the early communication:

I liked how early communication started regarding this. I know this time through we are trying to plan so that it would even happen for the first time, so maybe that was a reason. But I liked that communication seemed to be going early. From my high school teaching perspective, I, I kind of didn't engage with it as much early on. I was thinking about my courses and finishing up my school year and all that. But it was nice to know things were getting done, and I kind of felt like I was slowly getting in a mindset where, this is really going to happen!

By the end of the workshop, teachers were reflecting on how they had spent the past four days of professional development, some commented on the structure and supports provided. One teacher reflected on their need to have some level of autonomy in the classroom “I need some type of a boilerplate, which you guys are providing perfectly, and the leeway to change certain things up depending on how the class reacts.” Another teacher, who has led their own professional development experiences, commented on the scaffolding to reinforce key concepts “Getting to go through this training with you guys helped me to see some of the extra supports and structures you put in for teaching us.” They expanded on their comment “So I think that's where I personally found extra value for me. Getting to learn from how you guys are teaching this to professionals, so I have new strategies when I go back and help some of our new staff.”

One teacher shared some of their expectations for the week, and how those expectations were met. “I think my expectations coming into it were that it would be fun, and it was. That it would feel like a nice break from the regular types of PD that we normally do. And it did feel that way.” They went on to comment on aligning grading practices with that of Purdue instructors:

I did expect to get more of an understanding of your guys's grading policies, and the structure of the class, and just like the course policies and expectations. And I received that, so I feel like it met my expectations and then exceeded it.

One experience that all of the teachers felt strongly about was using the provided materials to teach a practice lesson. One teacher reflected “I definitely understand the value of letting every single person teach a lesson.” While another was adamant in saying “I would *definitely* keep getting instructors a chance to give a lesson.” They went on to explain:

I think there was a good amount of value in doing that, and I, when I heard we'd have to do that I was like, ‘oh man’, you know? Like, I knew it'd be work, but I didn't. But my back of mind is like, ‘Okay, good. I'm glad they're making me do this.’ Because even though I'm a teacher, kind of putting myself in that mind space where I'm going to be *teaching* a curriculum that was designed somewhere else, and sort of forcing me to engage with it in a way that isn't just ‘student’ with that session was so helpful.

A third teacher focused on how teaching the lessons helped with navigating documents as both a student and a teacher, and seemed to appreciate the chance to clarify the big ideas and intent of various lessons.

I think what's probably been most helpful as far as understanding the course is us getting to practice teaching the content that you've given us, and to be able to understand when looking at the documents provided. What of this content is just like notes for me as an instructor, versus like the pieces that we need to be delivering to students from like, your courses expectations, and then getting to practice that. And the processes and documents that students will fill out because I think that's usually the trickiest part is when someone has a new document the first question is ‘Okay, how do I fill this out?’ So us getting to do that will help us teach others.

Another teacher focused on the timing guide that was provided with each lesson, noting that it was broken into themes for how to spend large chunks of time, and allowed for teachers to have some freedom with the content:

I liked the pacing. I think a lot of high school teachers have a tendency to, if they use that type of guide that they'll put way too many timestamps throughout, and

it's really easy to get caught up in the timestamp so I prefer a much larger blocks of you know, for this 15 minutes for kind of doing that and it all the time almost always seems to work out

One teacher had not been looking forward to presenting a lesson, reflecting on the difference between presenting to students and presenting to peers. They ended up enjoying the experience and took the opportunity to revise and adjust the lesson with their students in mind:

I'll be honest, I am not a person that likes to take the floor, I'm not a person who likes to do a lot of presentations yet in my lifetime I've done tons of them. But it's not something I really enjoy doing. So today for me to have to do the lesson in front of you guys was definitely something really, really good. That helped me to see what I would be doing with my students, and when I put it together, I had our high school students in mind. I made the slides from what was in Brightspace.

And so seeing where I need to add things, you know, I really like that.

As teachers interacted with the content, many commented on approaches that may be valuable and engaging for their students. One teacher pointed out the repeated chances that students would have to engage with the material “What I love about this, you start out with a small challenge, and you're beginning to learn what is expected. And then it increases, expectations increase, and then to the final. Our design [course], I don't think allows for that.”

Other teachers focused on specific instructional strategies, such as teaching brainstorming. One teacher noted that while they have students brainstorm, it is often unstructured and they liked the idea of incorporating strategies from the workshop into their other classes “Yesterday with the very purposeful way of doing brainstorming, I think we need they really, really, need some of that structure particularly in the beginning.” The teacher that led the brainstorming (ideation) lesson was equally excited, sharing “When we did ideation, and we explored some new ideation techniques, that was exciting to me because I'm not a professional on techniques to get those going.”

Teachers who had some experience with graduate classes were excited to realize that the course content was also being preparing students for qualitative research. One teacher focused on qualitative research methods:

It's really cool to see how you guys have taken an introductory level course and not just sprinkled it with qualitative research and in like really rigorous academic

research processes, but like you weaved it through [the curriculum]. And I think that's so neat because that was something that I was not ever exposed to until grad school through [graduate level] courses and qualitative research methods. I'm excited for them to get to see like, okay, so you know, the interviewing that you've been doing, there's actually different methods of that. Here's one, ethnographic here, like, here are other methods of doing that, and that they get familiar with the terminology. So I'm kind of geeking out over here with excitement for them!

Another teacher reflected back to personal experiences with research methods and evaluation of sources is a central part to the Tech 120 curriculum. “It was something really ingrained in grad school and I haven't really been in that environment again. And so it was really cool to just have that like, ‘Oh yeah!’, the light bulb turned on again.” Yet another teacher reflected on their own experiences in both research and teaching:

There are a lot of teachers that don't quite understand that aspect of research. It is a subject that's near and dear to my heart, so I liked it. I enjoyed doing it. I enjoy looking for things trying to drive home the need for it, and this has that for students.

Throughout the workshop, teachers used the curriculum to lesson plan, and the learning management system to deliver grades and feedback. They spoke with former students, faculty from related programs, recruitment specialists, and the Polytechnic Institute's dean of students. They asked clarifying questions about the curriculum, and received pedagogical support. In reflecting back on the week, teachers seemed confident and excited about the upcoming school year. In reflecting on their confidence for the upcoming school year, one teacher commented “I think everything is going amazingly well, I think you've done just, man, just a great job. And I'm ready to teach it. I'm excited about teaching it. And so, I mean, that, to me, says something in itself.” Looking forward to the fall semester, another teacher expressed similarly “Like I said twelve times, you guys have done a great job, but I'll have no idea how well it actually prepared me for it until afterwards.”

4.3 On-going Support

On-going, just-in-time professional development and support took place weekly for one semester, one hour per school each week in an online learning environment. During this time, four (4) main themes emerged, and paralleled those identified in professional development - aligning with Purdue, identifying barriers, planning for ongoing support, and professional development. Themes are defined as accounts made by participants through interviews and observations that the researcher found relevant to the study and are limited to interactions the researcher could directly observe. These four (4) themes were further derived into multiple subthemes.

4.3.1 On-going Support – Aligning with Purdue

A continuing theme throughout the school year revolved around the alignment with Purdue's schedule for expectations, pacing, checkpoints, and adding and dropping students. Other themes captured in this section include teacher involvement and engagement outside of the standard curriculum, and proposed changes for future iterations of the dual credit course.

Early Communication

August 5th, two weeks before the start of the semester, a meeting was organized between the research team and the teacher facilitators to address any concerns from the summer and set expectations for the school year. One of the topics addressed was adding students into the program, as Purdue made a short notice change on accepting applications for the fall. Instead of accepting applications until the first day of class, on August 24th, it was announced on August 4th that due to Covid-19, applications would only be accepted until August 5th. One researcher shared updates with the group, reflecting: "It's been tough. We saw that deadlines changed, which made us rush around on getting students to their applications. We have a good number that are already admitted, and admissions is going to look through their applications again this afternoon." Many students had already turned in applications through the summer, and a live spreadsheet was shared between the research team, school administrators, and the registrar at Purdue with notes on which students were accepted, pending, or denied. The researcher

continued, offering support to students that may qualify academically, but miss the application deadline to join the class “We have some things that we can work with to be flexible, and working with some of the content, and we've talked about credit by exam assessments if we need to.”

Unlike other dual enrollment courses, because students are receiving directly transcribed credit, the application was also more difficult to navigate. One teacher shared an 11th grade student’s experience where more information was asked for “We've been telling students just their transcripts, but one called today after their applications still said it was incomplete. They said you need to submit not only your transcript, but your report cards for freshmen and sophomore year as well.” One researcher noted that this was contradictory to what they had been told, and may be accounted for through a software issue from the school:

Maybe they just said report cards versus transcript, but they did push back and say that it needs to be the full transcript. When I checked with the principals, they said, ‘Oh, yeah, our system is not doing it the way we wanted to.’

In addition to changing deadlines and confusion over transcripts, minimum GPA requirements were also altered, impacting a number of student participants. It was decided that although the course was originally intended to be dual credit only, participation would be open to any interested students. No course curricular modifications were made, so the high university standards and expectations were maintained for any students taking the course for high school credit only. The only difference in implementation between the students taking the course for dual credit or high school credit was access to the university’s learning management system. One researcher explained the difference between online course sections and access:

Essentially, there's three Tech 120 courses. There's one we are registering the dual credit students into so that is the credit side of the course. So that will only be the dual credit students, the ones who have applied and been admitted to Purdue. There are essentially four main checkpoint assignment submissions on that core shell, so this is where they log in to submit their assignments to be evaluated [by a Purdue instructor]. These checkpoint assignments are basically a collection of the individual assignments that they have, so it's almost like a portfolio assignment. Only the students that are working towards college credit will have access to [this course section], and that is for us to assign the Purdue grades...

There will be two other sections, one will be labeled [Tech 120 Highschool A], and the other, [Tech 120 Highschool B]. These will essentially be set up as non-credit courses. This will have all of the Tech 120 content in it, so it will provide access to the content for you as teachers and to the students. This will be for every student that you want to have access to the content, whether they are getting college credit or not.

The researcher went on, clarifying that teachers could use all of the LMS features on the non-credit bearing side to provide feedback for students, keep track of grades, and scaffold curriculum (see Figure 22). They then provided an example of what a student who is taking the course for credit would expect to see when logging into the university's LMS:

So essentially, if I, from the student perspective, so if I'm a [student from Highschool A], and I'm getting enrolled for dual credit, when I log into Brightspace, I will see two courses. One will be the non-credit side where I go to do all my day to day type work with the course. One will be for the Tech 120 credit side. I only go there to submit my four main checkpoint assignments.

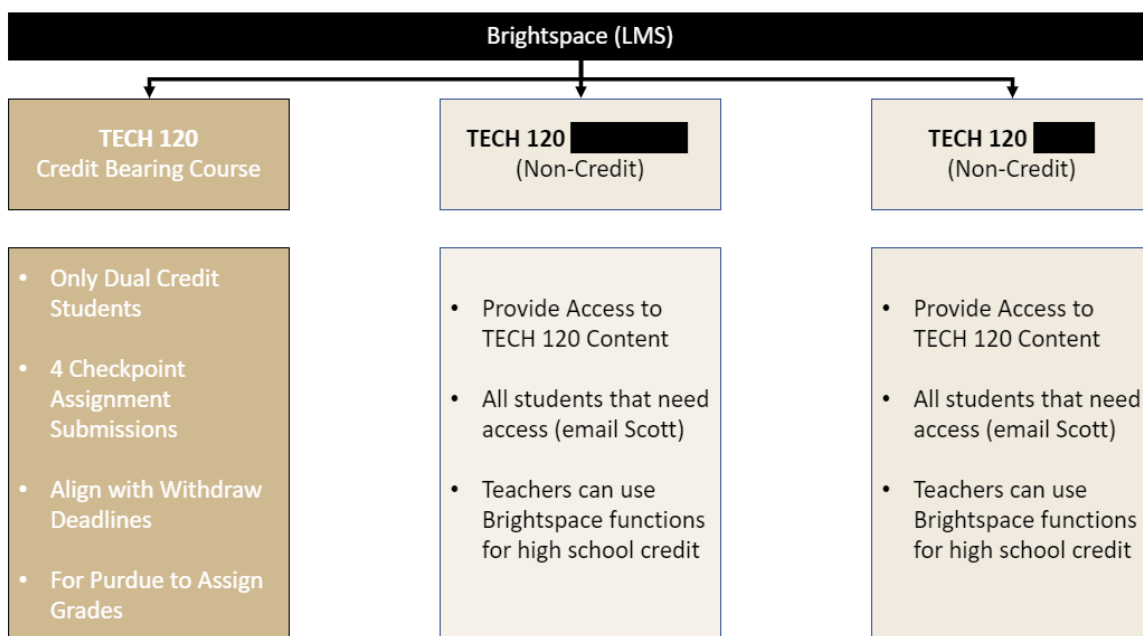


Figure 22. Slide Shared with Teachers to Explain Differences in LMS Courses

It was discovered in the mid-semester interviews that this was a major point of clarification for one teacher. They reflected on how their understanding of their roles and responsibilities changed since the summer:

[The confusion] at the beginning, it was knowing what was the role and responsibility of [the teachers in my building] as facilitators versus you as instructor verses [other members of the research team], as I'm not even sure what label to use for them, the hierarchy. And I know you guys had explained that [this summer] and might have even had a, like a model or chart to refer to. But initially, there was some confusion around that. But after you guys kind of helped clear that up [in August] of like, 'These are the only pieces you guys are in charge of' then it was much clearer.

Teachers were also informed by the researcher that due to FERPA regulations "You will not see the four main checkpoint evaluations that we do on our end because that's separate and we kind of have to keep that piece separate." It was further clarified that while there are only four checkpoints evaluated for credit, "They still include all of the assignments. So 'Checkpoint 1' is lessons one and two, 'Checkpoint 2' is lessons three through six. 'Checkpoint 3' is the last one before [finalizing their decision] to remain or withdraw from the course." The specific dates of checkpoints were chosen to align with the university's calendar of withdraw deadlines, each occurring about a week before students would need to decide to stay in the credit side of the course or not. This idea of checkpoints as support and safeguards, unique to the facilitator model, was emphasized several times. One researcher noted that with this being a directly transcribed grade, it has the potential to do harm if poorly executed, summarizing "We don't want to get them to a point where they do poorly, and that sticks with them for the rest of their lives."

Other concerns addressed during the meeting were where teachers should go if they needed help with a variety of things throughout the school year. While each problem would have an appropriate corresponding department on campus, the facilitator model provides teachers with a direct contact with a faculty member, as one researcher went on to describe:

If it's helpful for you all, I think [the Student Success Coach] can probably direct traffic. So if you if you have any questions and you're not sure what to do, run them through [him], and he'll just follow them to [someone from the research

team], or recommend a reply back. [For example, he may] say go after ITaP, and here's their phone number. That way you and the students feel like you've got one point of contact that we direct traffic for you.

Before concluding the meeting, teachers were reminded of the on-going support they would have available throughout the semester. One researcher explained that the meetings would not be required, but rather a virtual “opt in weekly meeting, where if you wanted to come in and see what are the updates, if there's any changes being made at the college level, or how we approach things with being online versus face to face.” Another researcher clarified:

It will be a just-in-time professional development because we covered a whole lot this summer really fast. And then you might have forgotten some things because I've forgotten pretty much everything that happened this summer myself, and maybe I repressed it, I'm not sure but this would be an opportunity for you to get caught up on a weekly basis as needed for you.

Expectations

One of the themes that emerged with aligning with Purdue were the teachers' expectations of the students and their role in teaching the curriculum with fidelity. Some teachers embraced their role as facilitators by taking a step back from the kinds of supports they would typically offer in a classroom. One teacher reflected, “I've just been teaching it as if all of them are taking it for college.” Another teacher offered “I wanted them to succeed or fail on their own, you know? In a college level course, without me feeling like I was dragging them across the finish line.” They continued “I didn't want to be another just person getting them through this course. And then they get to college and they're like, ‘Oh, my God, I'm not prepared for this because everybody's held my hand.’” Other teachers felt that more scaffolding and supports were needed, as one explained:

By putting our students in the same category with college students, we, in my opinion as a high school teacher, I need to make sure that I am bringing enough of everything to the table for them so that they can be successful. I don't see from your vantage, you know? I don't have college students, I have high school students, so pushing them is horrendously important.

Two other teachers shared how they communicated assignment expectation and deadlines outside of class time to encourage completion. One shared “We’ve had students not turn it in, but I feel like we’ve like reached out to parents and you know, had talks with them and kids.” The other teacher had similar methods, communicating directly with the students:

I send a couple emails during the week to let them know what's due. It's due and this is what you need to have done whatever day, because they're high school students, you know? So I figured I can really put it in front of them, and I've had fairly good luck, but still, I'm struggling with them doing the work.

As teachers shared what their expectations were for the school year, they also reflected on student expectations and their level of mental preparedness for the course. Some students sought out constant validation, as one teacher reflected

They just want to make sure that they do everything right, and so they ask a lot of questions to just show ‘I’m concerned, I want to make sure I get this turned in on time. I want to make sure I followed everything that goes required and asked of me.’ They’re just eager to kind of have the pressure and added seriousness of a college level class.

For other students the expectations for the class were much higher than they had anticipated. One teacher summarized “They thought they understood, and then they realized that we had higher expectations for them.” When pressed about what these expectations were, much of it was tied to the significance and impact of assignments:

I think for any students that were overwhelmed, there's maybe only one or two. For one, some of the pre-class homework was maybe the hardest part for students to get used to, because we don't have homework. I mean, students are expected to do their work outside of class if they don't finish it in class, but we don't assign specific homework. I think right off the bat, a lot of students like maybe neglected, or didn't care or realize how much they needed to care about getting their pre class homework. Even though we addressed it, every day, we walked through it, we said how important it was, a lot of people got behind on that in the beginning, and then it stacked up.

Another teacher pointed out that assignments may have a similar structure to other high school courses they may have taken, but the level of detail expected from a college course was much higher:

I think it's probably not exactly what they expected. And I think part of that is, they probably didn't expect some similarities with [previous courses]. After they [saw some of the assignments] they go, 'This is kinda like what we did in [other design courses].' They probably didn't expect us to say, 'Yeah, but your research is gonna have to be a step up from what it has been, and you're gonna have to do APA citations, and, oh, you're gonna have to work with your group members for a couple hours outside of class here.' So I think they probably were expecting something different.

Teachers also clarified that higher expectations of course work was beneficial for those students, sharing "I think they seem more of a real picture of what college is like from the point of, they're going to be given more information, more requirements, and they have to get it done."

Having regular contact from a university instructor, one of the benefits of the facilitator model, also helped to maintain expectations across assignments and calibrate teachers regarding grading. Teachers were very receptive to this, noting early into the semester "With grading, I want to make sure I'm on the same page as you. I want to make sure I'm directing them into the pathway that leads to your expectations." Expectations were aligned throughout most of the semester, but there were exceptions. After the first checkpoint, the researcher compared notes with one teacher, sharing "For the most part, our grades aligned, but there was one student who I didn't think he performed where he should. And so his grade for me is much different than from you." The researcher shared comments and feedback from the checkpoint that was provided to students in an email to the teacher, without sharing how the student was scored (see Figure 23).

Good morning [REDACTED]

Just looking through our two gradebooks, it looks like there are just 4 that are in both the high school and college credit versions of the course. The only discrepancies are with [REDACTED] and [REDACTED].

[REDACTED] did not turn in Checkpoint #1 at all, and was missing 4 assignments from Checkpoint #3, so her grade for me is lower than it is for you. In Checkpoint #3 I only took off points on one of her submitted assignments, her PoV from L9 IC:

"No insight identified. Why do students not feel safe? What is the impact of students not feeling safe? "

[REDACTED] is Checkpoint #2 I also took off points for her PoV:

"I see that you have three insights, but right now they are too 'surface level' - it looks like you are just making observations. This exercise asked that you make up a reason why the old lady might not look well, why she is waiting on a heart, or why she does not look hopeful.

Ex.) The woman needs a new heart because she is expecting a granddaughter in the next 6 months, but the doctors only gave her 3 months to live and she has already waited 29 days."

"For future POVs, please make sure they follow this format:
[USER] needs [NEED] because [INSIGHT].

Ex.) [The woman] needs [a new heart] because [she is expecting a granddaughter in the next 6 months, but the doctors only gave her 3 months to live and she has already waited 29 days]."

There were also several points [REDACTED] lost in her LS Reflection:

"Plan on adding more detail to your future responses. An example would be in Question 1 where you were asked about how you might use prototyping in your major. Your response was not specific enough that I could tell what major you are considering or how you envision prototyping in it."

"It looks like you missed this in the rubric. It may seem odd to ask for examples from the curriculum for a self-reflection, but the point of this assignment is to reflect on what we have done so far in Tech 120. If you feel you have strengths with problem solving (not an element of design thinking), what assignments led you to think so? Same goes for starting small (still not an element of design thinking) - you see this as an area for improvement, but what readings/assignments/performance of classmates have made you think so?"

"You left one of the responses completely blank."

Otherwise it looks like she received full points on the other assignments.

[REDACTED] looks like he is doing better in my gradebook than yours, but it is close.

Feedback from Checkpoint #2 Included

"Everything you have here is great except the format. For POVs, please use:
[USER] needs [NEED] because [INSIGHT].

so your statements would look more like:
[Jenny] needs [to find a way to pay for large unexpected medical bills] because [her insurance provider is refusing to cover the expenses because her son caused the accident].

Of course, you would not include [] in your POV, I only included them to show how the sentence is diagrammed."

And for his "How" from the observation assignment

"It seems you deleted this entire column, but you were so detailed on the other parts of this assignment, and spoke to some of the 'How' in your 'What' responses that I decided to give you partial credit for this. Please do not modify the formatting of future assignments."

The only feedback in Checkpoint #3 was also centered around his PoV insight:

"Missing the insight in your PoV. Why do students need to feel safe? What are the ramifications if they do not?"

Figure 23. Student Checkpoint Feedback Email with Teachers

The Student Success Coach was supportive as they reviewed the student submission with the teacher and compared rubric expectations, noting that even though the teacher grade had no impact on the college grade, it may be important to have a conversation with the student:

That's okay. As I said, if there's a different reasoning for it, then I want to be aware of that. But I also want you to know that he may be upset with his grade. If he thought that he was doing well, and then he gets it back from me he may think, 'Oh, this is really bad.' That was the only discrepancy that I really caught there.

Another exception, also in the first checkpoint, dealt with academic dishonesty. The university uses a software tool that is built into the LMS to check for plagiarism across both student assignments and web sources. Because students would be submitting the same work to both the high school and Purdue LMS, the software was disabled for the high school side, surprising a teacher when one of their students was flagged. The topic of plagiarism was brought up to all teachers in a weekly meeting. They were encouraged to have conversations about what

constitutes academic dishonesty, and a private conversation was had with the teacher of the student about how the work was identified and consequences for their student. The teacher mentioned that they had a discussion with their class at the start of the school year, “I had a conversation with them about the importance of you know, like, college plagiarism and high school plagiarism are two very different things. But I didn't think to look for it.” It was determined that the student would not receive credit for the first of four checkpoints, but the researcher encouraged the student to continue, noting “The first checkpoint was not very many points, is it's just those two assignments and they really weren't much. The next three [checkpoints] will be much more important.” It was further pointed out that for not just this student, but for any student to:

Make sure that students know to look at their maximum final grade. So as an example, here we have [one student with] a current grade of a D in the class, but their max final could still be an A. So this only shows where they are at one moment in time, and there's still a lot of points to be had, if they gets things turned in. So just make sure they know that there's still a chance.

As the semester continued, teachers started to note a change in the quality of work, and how students were rising to the expectations of Purdue coursework. It was evident in conversations that there was a shared sense of pride in the growth of the students. One teacher reflected on how students adapted their feedback to turn in higher quality work:

I feel like I'm starting to see really good growth in the kids. That at least the ones that I'm grading, I'm seeing a couple of them being really receptive to the feedback and making the changes. I like that they're starting to see the connections between what we've been teaching him here for the last three years, versus what you're expecting out of them.

Another teacher commented on how coursework from other design-centered courses has impacted student performance. “I was so proud seeing them doing their presentations the other day. I think the fact that we've trained them to be able to do this, we've prepared them for this.”

As time went on, students seemed to gain more confidence in their abilities and their readiness for college. For some students, their experience acted as a validation that they could complete college level work. One teacher shared “I think all of my kids were planning on going to Purdue anyhow, so if anything this reaffirmed what they should be doing and why they should

be going to college.” Having all college bound students was not an experience shared by all teachers, as several students were intimidated by what the workload might look like. One teacher how both expectations and confidence changed throughout the semester:

Their understanding of the class has shifted for sure. Like, I don't know what they expected, but I think that as we're getting into this, they have a better understanding of what the expectations are. I think they're seeing what college is like. And I think they're also seeing that they can do it.

Not only did students think they could do it, they executed the final project with a high degree of proficiency. Students identified a problem in their community, created sketches and CAD models, made mock-ups out of cardboard, and finished the design process with highly functional prototypes (see Figures 24-27).



Figure 24. *Identifying a Problem in the Community*

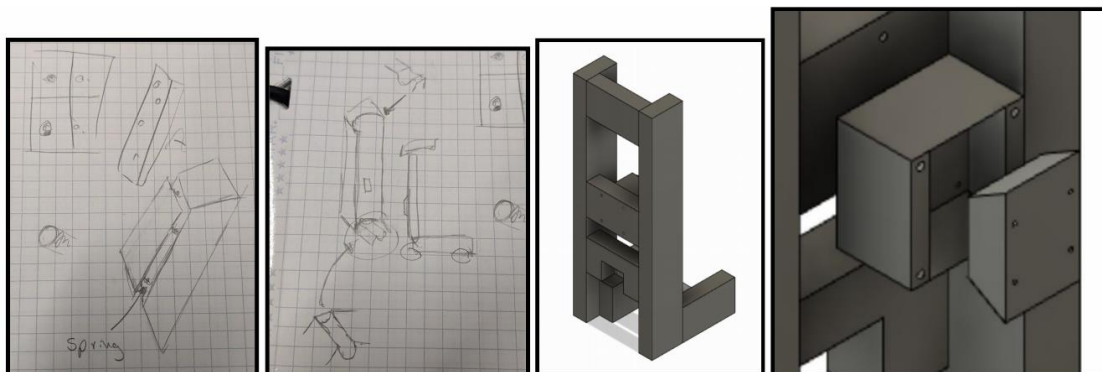


Figure 25. *Sketches and CAD Models*



Figure 26. *Cardboard and Rough Mock-ups*

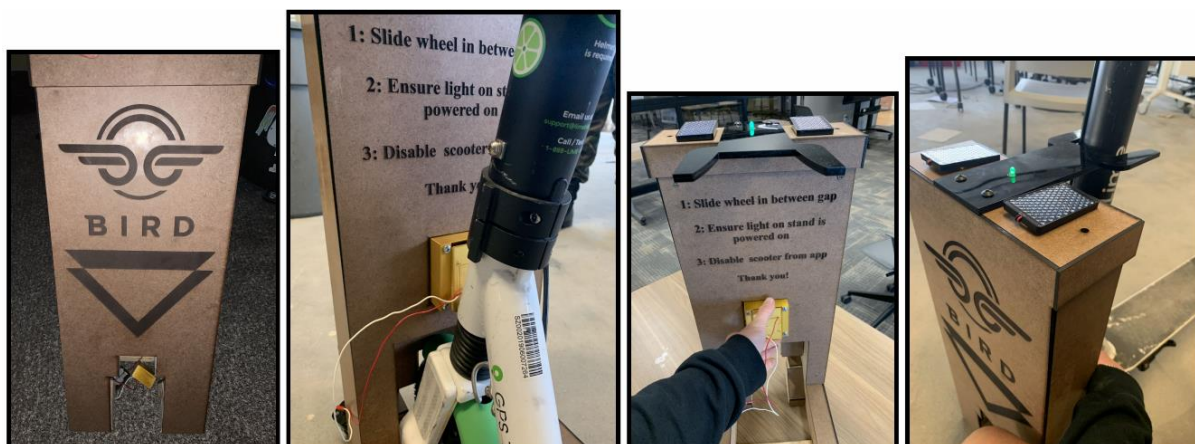


Figure 27. *Functional Prototype*

Pacing

The on-campus implementation Tech 120: Design Thinking in Technology utilizes a ‘flipped-classroom’ approach to curriculum. Students have assigned readings and videos to complete outside of class and use most of the in-class time to work in small groups, however, they only meet twice a week throughout the semester. For the dual credit version of the course, students may meet four to five times each week giving teacher facilitators some flexibility in what to focus on during class time and what to assign for homework to still meet the same pacing

expectations of about two (2) lessons each week. As the high school started courses a couple of weeks before Purdue, on paper it seemed that students would have plenty of time to submit assignments and receive feedback before turning anything in for the checkpoints for college credit. This did not seem to translate to more time for the students, as one teacher commented on how their class felt with the workload, sharing “I think there are a couple that kind of got a little bit of a shock. These college courses, the pace, you know, just keeps coming.” Another teacher shared a similar experience:

I do have a couple students that are panicking just a little bit because they're not used to the pace. It's something that we've never required, like due dates, which I can see how it's kind of hurt them. They're good students, just panicking a bit.

This sense of extra time and student fatigue led to teachers providing more scaffolding and time on assignments early into the semester, leading to a feeling of haste and urgency toward the end of the course. Another teacher felt that these adjustments were not properly preparing students for college level work, as they recalled a conversation they had with another facilitator “‘Oh, we need more time’. And like, we don't have more time! There is no more time! These kids have to operate this at this level, and if they can't keep up, then that's how college is going to be.” They continued:

For me, it was frustrating a couple of times to hear others say, ‘Well, we need to give them more time.’ And it's like, no! They need to learn how to do this stuff on their own time, and they need to understand we need to treat this like a college class. This is Purdue freakin’ University! Like this isn't easy! I don't want them to have that false sense of what college is like. Now, I did agree that it would have been nice if we had more time with them to spread that out, but at the end of the day, we still had to keep them on pace. My big fear was that if we kept giving them an extra day here and an extra day there, that we were going to get to the end and they were going to be rushing, and I didn't want that.

Teachers adjusted to the pace of the class in different ways. At one school the teachers reflected, “At some point we got a lesson behind, so we had three lessons in one week, which was a lot, and then a lot to grade.” To stay on track after that, teachers published a schedule to keep up the pacing of the course and set student expectations (see Figure 28):

We have it as an actual Google Calendar that I shared with all the students so now it's populated in their schedules. They get reminders, like automated reminders, right before a class starts of like 'Hey, don't forget your pre class work is due before less than 15 tomorrow.' Students have, every student said that that was super helpful, and they liked that.

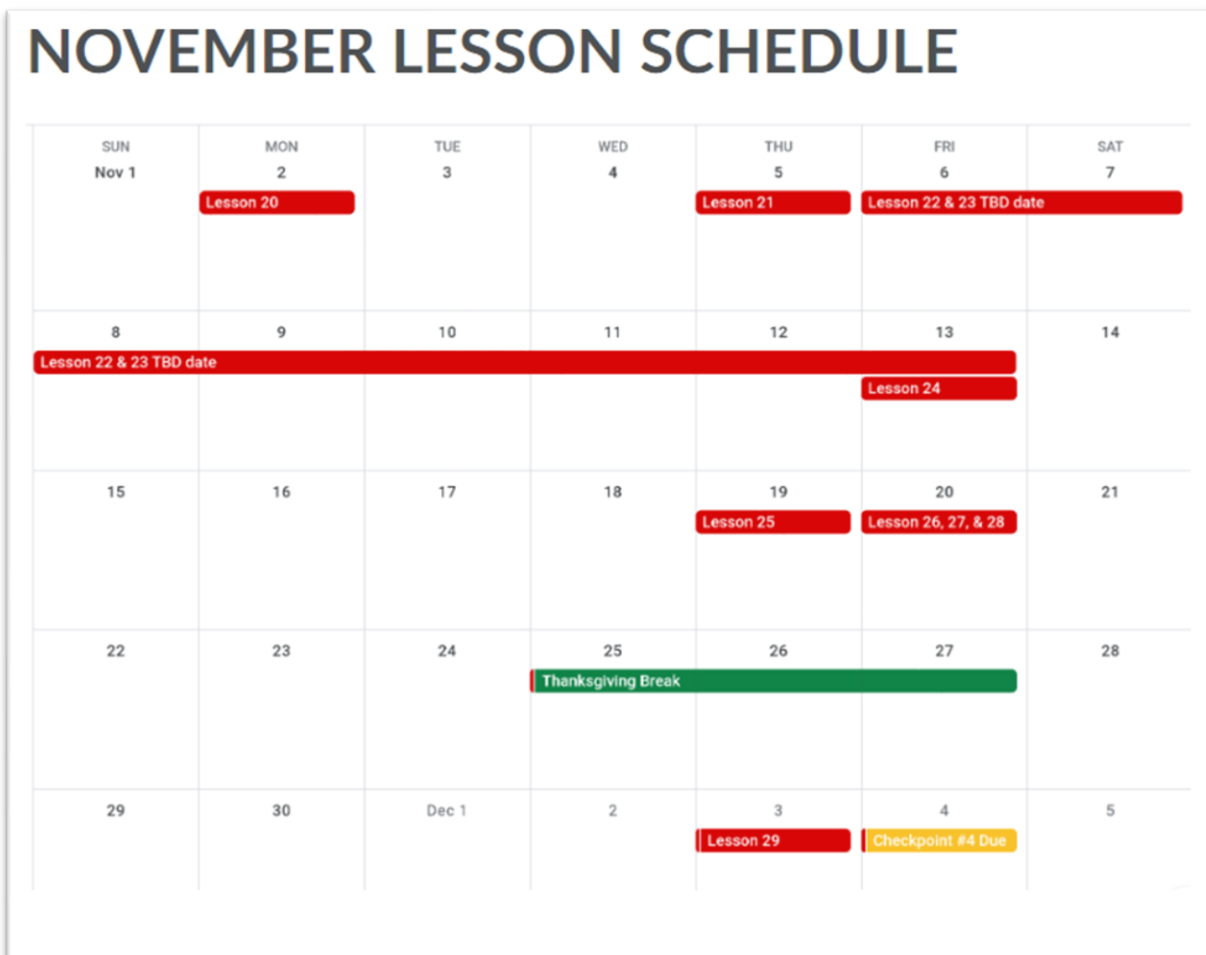


Figure 28. *Google Calendar Pacing Solution*

Having weekly meetings with a university instructor of the course also helped keep the pacing for the lessons on track, as suggestions were offered for which lessons could be combined, and how classes may be altered for a four day/week schedule. An adjusted schedule

with school breaks (see Figure 29) and Gantt chart (see Figure 30) for the final project was generated and shared with the teachers:

Going toward the end of the school year, the ones that are in like this light green color, are a little bit flexible. So like 22 and 23, we didn't actually have class time for those days, we just had to check in with the students and see where they're at. That's time for them to prototype. So there is some flexibility in the schedule to save some days here, we also have the presentations are the 26th, seventh and eighth lessons 26, seven, and eight. So if you want to have all the all of the presentations turned in, by the 26. So before Thanksgiving break, and then they're just presenting them either as a PowerPoint or a video or whatever, and you're having a classroom discussions after, you can save some time there as well.

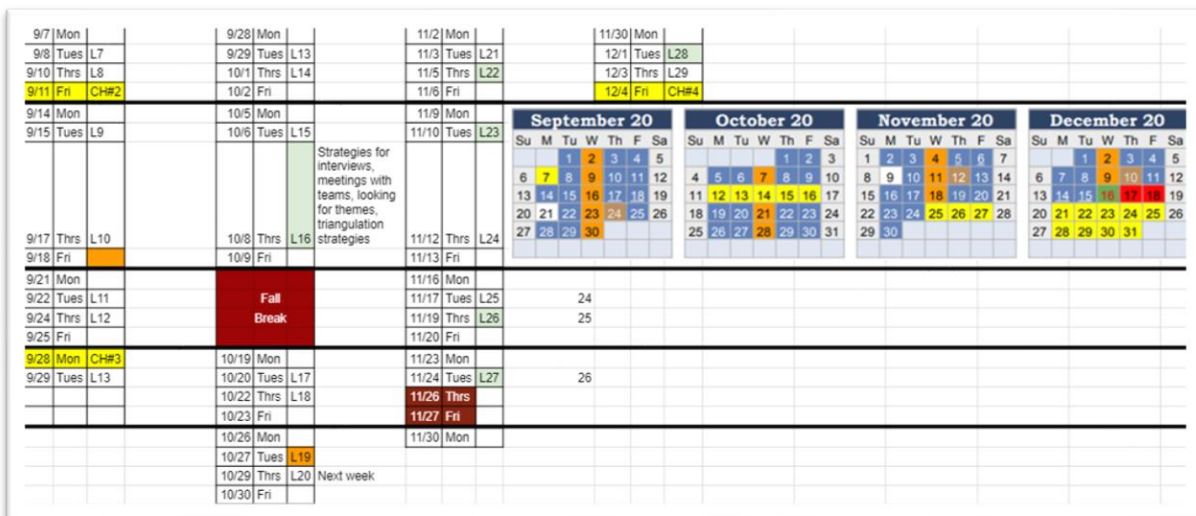


Figure 29. Adjusted Schedule

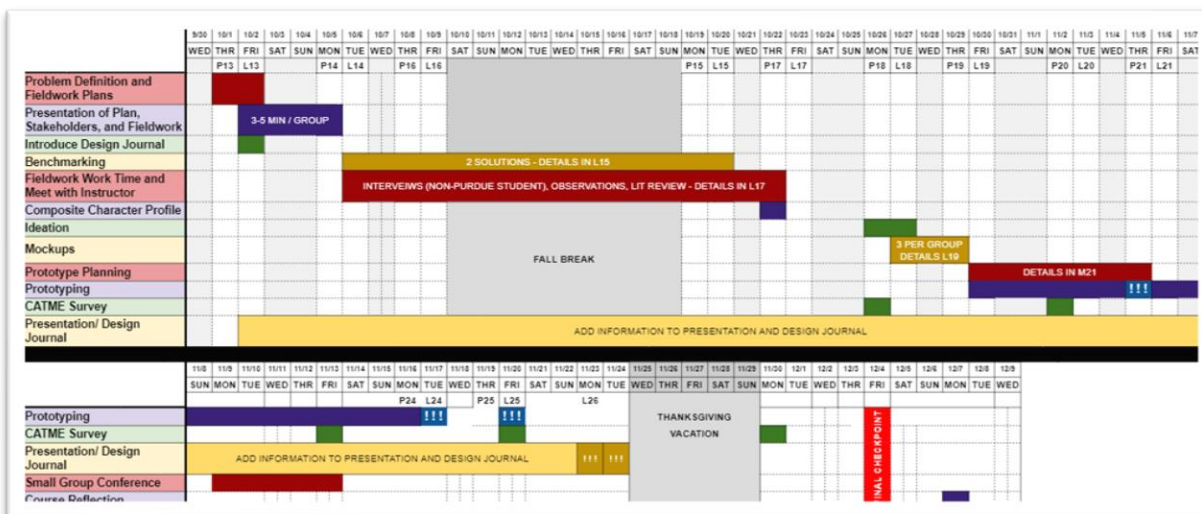


Figure 30. *Final Project Gantt Chart*

Another teacher reflected on the modified schedule and Gantt chart provided from the university instructor as supports:

We got started a little bit ahead of the university, but as Purdue kind of started progressing, it was nice to get some feedback from that side about our pacing. So I think that was the biggest thing for me that helped me feel reassured where we were. Keeping that that end goal in mind so that we didn't scramble and have to cram stuff into too fast at the end.

At one point it was suggested that some objectives may have already been addressed in previous courses, and assignments may be modified to allow students to focus on material that was unfamiliar:

Researcher: Are there spots to where there are some overlaps? Like we were talking about that Venn diagram at one point, maybe there's some things to document or keep track of or share similar work? Maybe you've done some of this stuff in other courses, so maybe there's a way to help with pacing because there's something that's already been done or documented somewhere else through the school model itself. I don't know if I'm explaining that correctly, but you know, I think there's probably some opportunities where there's some things that have already been done. If we can show kind of some evidence for that, pacing might be different.

Or the other side of it is a little bit of overlap is good, and it reinforces everything. So just thoughts on that?

Teacher: I think they kind of need all of it at this point. That's my opinion.

At the end of the course, teachers were asked to reflect on the pace of the class and where they may make adjustments in the future. One teacher thought about how large a role prototyping played, and how it felt a little rushed at the end. "For my own pacing I could see trying to condense some of the earlier phases of Project Three, or possibly instead condensing Project One a little bit, just to try to get some of that time there for the prototyping." Another reflected that the Google Calendar was something they would continue, and a third noted that some of the prep work just doesn't translate well to in-class work "I think some of this just needs to be done outside of class. You know?"

Checkpoints

Formative and summative assessment are arguably the most important aspects of the facilitator model, as these are the primary determining factor not only for a student to continue for dual credit, but also the basis for their transcribed grade. The course was split into four (4) checkpoints, of which the first two (2) matched the official Purdue withdraw deadlines, and the third checkpoint taking place at the end of a major project of the course, roughly one month before the last drop date on Purdue's calendar. The final checkpoint consisted of the student's design journal, which included roughly twenty (20) assignments and all of the research for the final project of the course. At each of these places in the curriculum, students would be re-directed to submit a bundle of assignments, everything since the last checkpoint, to the university LMS (see Figure 31).

PURDUE CHECKPOINT #1

This Checkpoint is due August 28th by midnight.

This is the first of four checkpoints to submit your work for review by an instructor at Purdue University. Be sure to turn in your best work from this time period, making changes as necessary based on feedback from your teachers.

Please log in to your Purdue career account to submit the following files for review:

1. Lesson 01: Prototyping [In-Class Individual Submission]
 2. Lesson 02: Design Thinking and Innovation [In-Class Individual Submission]
-

Figure 31. *Purdue Checkpoints as they Appear on the Curriculum Side of the LMS*

Figure 31 *continued*

PURDUE CHECKPOINT #2

This Checkpoint is due September 11th by midnight.

This is the second of four checkpoints to submit your work for review by an instructor at Purdue University. Be sure to turn in your best work from this time period, making changes as necessary based on feedback from your teachers.

Please log in to your Purdue career account to submit the following files for review:

1. Lesson 03: POV Group Exercise [In-Class Group Submission]
 2. Lesson 04: Project 01 [Before-Class Individual Submission]
 3. Lesson 04: Peer Critique Feedback [In-Class Individual Submission]
 4. Lesson 05: Project 01 Reflection [Before-Class Individual Submission]
 5. Lesson 05: Project 02 Observation Planning [In-Class Group Submission]
 6. Lesson 06: Project 02 Observations [Before-Class Individual Submission]
 7. Lesson 06: Project 02 Problem Definition and Fieldwork Planning [In-Class Group Submission]
-

Figure 31 *continued*

PURDUE CHECKPOINT #3

This Checkpoint is due September 28th by midnight.

This is the third of four checkpoints to submit your work for review by an instructor at Purdue University. After receiving feedback, this will also be your **last chance to withdraw from the college credit portion of the course**. If you have concerns about the status of your grades or your progress so far, please have a conference with your teacher or Student Success coach from Purdue.

Be sure to turn in your best work from this time period, making changes as necessary based on feedback from your coaches at PPHS.

Please log in to your Purdue career account to submit the following files for review:

1. Lesson 07: Project 02 Information Literacy [Before-Class Individual Submission]
 2. Lesson 07: Project 02 Information Literacy [In-Class Group Submission]

 3. Lesson 08: Project 02 Two Ethnographic Interviews [Before-Class Individual Submission]
 4. Lesson 08: Project 02 Thematic Identification [In-Class Group Submission]

 5. Lesson 09: Project 02 Benchmarking [Before-Class Individual Submission]
 6. Lesson 09: Project 02 Benchmarking & Solution Development [In-Class Group Submission]

 7. Lesson 10: Project 02 Ideation [Before-Class Individual Submission]
 8. Lesson 10: Project 02 Ideation [In-Class Group Submission]

 9. Lesson 11: Project 02 Solution Demonstration [Before-Class Group Submission]
 10. Lesson 11: Project 02 Solution Demonstration [In-Class Group Submission]
-

Figure 31 *continued*

FINAL PURDUE CHECKPOINT

This Checkpoint is due December 4th by midnight.

Congratulations! This is the final Purdue checkpoint! As always, be sure to turn in your best work to represent your final project in this design journal, making changes as necessary based on feedback from your teachers.

Please log in to your Purdue career account to submit your Design Journal for review, including the following:

1. Meet the Team
 2. Executive Summary
 3. Clearly identified work from all team members for Lessons 13 - 26
 4. Link to your final presentation video for Meeting 26 (make sure this works!)
-

Teachers were understandably anxious about providing adequate feedback to their students. One commented “The only thing that I can see there's going to be an issue from is if your grades and my grades differ wildly.” Another teacher had a similar comment:

The kids that did submit it to Brightspace, I thought they did exceptional. So the question is, was I grading too easy? Or did they really do as well as I thought they did. So I'll be interested to see where my feedback on Brightspace meets yours.

Other teachers had similar experiences with work they had seen, but were concerned as some of their students only submitted their assignments to the checkpoint and they had not had the chance to provide feedback. One teacher asked the researcher:

I'm interested in hearing feedback from you. As far as like, for this unit, I only had her for this checkpoint, I only had maybe half the kids submit anything for me. So I don't know how well most of my kids did. But the ones that submitted I thought they did actually a really good job. And so I would be interested to see if you could maybe give me even just some feedback and how I scored them versus How you did or would have, and you don't have to be specific about anything. But I felt like I almost gave too good of grades to this last checkpoint.

The actual quality of student work was very comparable to that of university students, with some high school students going above and beyond what might be expected from an on-campus student. The researcher shared these insights to encourage teachers to continue providing actionable feedback:

It's very, very similar. Very similar. The work that I'm grading, at least for the first two checkpoints, I haven't looked at Checkpoint 3 enough yet. It's been right in line with what I would expect of college student work. And that's on both ends of the spectrum, because I still get students that are here at Purdue, and they turn in some work that misses the mark, and it's like, what were they thinking? And you get that too from high school students, but it's not disproportionately high on the low side. All of the students that I'm getting, the majority of them, are right where I expect them to be. Some, they're going above what I would normally see from Purdue students, and there are some that are having the same kinds of struggles and the same kinds of setbacks that Purdue students would have. I'm seeing common trends across the board that's in a positive direction.

The researcher also had the role of Student Success Coach, where they reached out to participating students about checkpoints, progress in the course, and other support throughout the year through a number of emails (see Figure 32). Lists of students who had not yet submitted their checkpoints were shared with facilitating teachers as an extra support, as they would have more reliable communication with students, or may be able to provide additional insights into individual situations. It was discovered that some students had difficulty accessing the additional LMS:

For Checkpoint 1, we still have the these nine or so students here who have not submitted it yet. We would still like to get them in if possible. The ones in red again, they haven't accessed Brightspace on the Purdue side yet, so they may not know how. I don't know who exactly these students belong to, but we can tell them that first checkpoint is due by Friday. We will actually accept it until Monday, but let's tell them Friday.

Good evening «First»,

As your Student Success Coach, I wanted to reach out to you and see how your experience is so far.
«Comment»

Key parts of design are iteration and fast failure. Failure does not have to be a bad thing, in fact the key point of failure is revision. If I could encourage you to do one thing, it would be to keep your iterations going! We have until September 28th until next Checkpoint - keep seeking teacher feedback and iterating. Everything you learned from Project 1 you will reapply in Project 2, and everything you learned in Project 2 you will reapply in Project 3.

Now that Checkpoint #2 has been evaluated, please take a moment to check your updated grade and percentage in Brightspace. I would also encourage you to use the *Class Progress* tab to see not only your current grade, but the possible range for your end-of-course grade as well.

As mentioned, I want to see what your experience is so far. **Please respond** with this informal one-question survey:

How are you enjoying Tech 120: Design Thinking in Technology?

- A.) I am loving it.**
- B.) I have some questions.**
- C.) Give me a call so we can talk about the withdraw process.**

If you, or friends you know, are considering withdrawing from the college credit portion of the course we have until October 20th to finalize that decision. I will also make administrative drops if anyone has less than a B- at that time to protect your college GPA and eligibility status for financial aid. I am here to support you, and want to see this both you and this program succeed - not only so you can receive Purdue credit, but so that we can continue to offer opportunities like this to future ■■■ students.

Thank you for your time, and I will look forward to hearing back from you soon!

Scott Thorne

Design Thinking in Technology Instructor
Purdue Polytechnic Institute
Technology Leadership and Innovation

Figure 32. *Example Student Email Template*

As the year continued, another discovery found a group of students who completed the work on the high school side, but were reluctant to submit it to Purdue. The Student Success Coach brought this to the teacher's attention at a weekly meeting:

So Checkpoint 2 is missing these seven students, and the ones that are in bold, so [this group of students] has things turned in to the non-credit version of Brightspace that you have access to, but they have not turned that in to the Purdue side for the checkpoint. That might be an easier way to get them to go and submit what they have.

The Student Success Coach reminded the teachers that these checkpoints were established to support the success and continuation of students in the program, not to penalize them:

I'm still accepting those as late, and I'm not penalizing them for that, but let's try and get those in as soon as possible. So that list at the top, yes, should have been in by Friday, but let's just keep the pressure on the students to get whatever they do have [completed] turned in.

Making the decision to give students credit for submitting their second checkpoint after September 11th was also aided by the fact that Purdue had originally posted October 27th as the last day to withdraw from a course. Teachers were made aware of students that may be struggling, and would have time to provide scaffolding and supports locally. It was emphasized, however, that the third checkpoint would not be as flexible:

Checkpoint 3 is kind of a big one. There's a hard deadline of one week after Checkpoint 3 to submit, so it's due on September 28, which is in a couple of weeks. Just like [previous checkpoints], we have a couple of students who have not submitted yet, but they have submitted before. If this is happening around Checkpoint 3, we want to give them one week of this is when it should be due [to finalize their submission]. If you can, have students get those turned in within the week after because they had issues, because they're a perfectionist, because whatever it might be, let's get those, and then not advertise it to them like that, but keep the pressure on up until that week. Then if it's late beyond the fifth, my instructions from [the research team] is to go ahead and remove them from the college credit side, and that's just to protect their GPA.

Having students submit their third checkpoint four (4) weeks before the last drop date allowed for the Purdue instructor to provide grades and feedback to students, and identify concerns before it was too late. It was a goal that all students completing the course would earn a

B or higher, as a 2.0 GPA from a C could cause problems with financial aid eligibility and registration for those seeking to continue into post-secondary education. The researcher was transparent with this information when meeting with the teachers:

I will draw your attention to a couple of important dates at the very top. So October 5, that's this coming Monday, students that do not have Checkpoints 1, 2, or 3, we're going to go ahead and withdraw them from the course. So if we can have all of the students who are definitely want to be doing this [for college credit] turn in something by this week, Friday, like, hopefully, today or tomorrow, but at the latest then Friday. Then at least they have something in that I can see, give them [grades and feedback]. This should help us figure out if they're on the right trajectory, or if that quality of work looks like it's going in the wrong direction. We have until October 26. That's the last day to withdraw students from the course. But they may need some lead time, I don't want to give them a list on the 26th have them not get through the system and then be stuck in the class, if they're not going to have that degree of success that we're hoping for. So I want [the registrar to] have plenty of time where they can process [students to drop] and it's not going to negatively impact them. So first, let's make sure they're actually getting things turned into the checkpoints, and then we'll have another discussion before the 26th to see if there's any students that this doesn't look like they're going down the right path.

Throughout the semester, the Student Success Coach continued to provide teachers with lists of students that were missing checkpoint assignments, and identified students that scored a C or below on any checkpoint. They communicated with the students at multiple points in the semester to check that they understood the course requirements, answer questions, and to provide context for why they may be administratively removed for grades that otherwise may seem acceptable. As shown above, they also encouraged teachers to meet with students about their trajectory and performance after the third checkpoint, but before the last drop date of the class.

By the end of the semester, no students had scored a 'C' or lower, with twenty-three (23) students earning an 'A', and three (3) students earning a 'B'. A total of seventeen (17) students withdrew from the course, four (4) after the second checkpoint, six (6) after the third checkpoint, and five (5) before October 26th. One student, who was otherwise doing well, withdrew after

contracting Covid-19 on November 7th, and one final student was submitted by teachers to be removed after the university extended their withdraw deadline to December 4th to help students who may be struggling with Covid-19 related stress.

Adding and Dropping Students

Using two LMS courses had its advantages throughout the semester. It allowed for all students, those taking for dual credit and just high school credit, to view the curriculum and submit assignments to teachers for initial feedback, and allowed just those taking the course for dual credit a place to submit their checkpoint assignments. Unfortunately for one of the two schools, it also led to some confusion.

All students had access to the course content, and as such were not aware of a need to be concerned with access to the college submission course shell. It was August 27th, fourteen (14) school days into the semester and the day before the first checkpoint was to be submitted that a teacher realized that none of their students had access to the necessary course for submission. The facilitator called the Student Success Coach at 10:00am with details about the problem, and the Student Success Coach was the main point of contact with Purdue's information technology department throughout the day.

By 5:30pm August 27th, the technology department generated unique career account setup passwords for every student in the course. Since teachers had all gone through FERPA training before facilitating the course, these files were shared with them securely through a two-password authentication FileLocker, and teachers communicated the information directly with each student the next morning. While the issue was resolved quickly, the experience stayed with the teachers as they continued to reflect on how they lost two class days in the final interviews after the course had concluded. One teacher summarized the experience:

The main thing I wish that would have been different was just the whole enrollment process. How far removed we were from the ability to get them logins, or even know if they're in Purdue or not, it just, I think that whole part was a little hectic.

It should be noted that this group of students appeared to be in the college credit side of the LMS, their user accounts were all enrolled in the course. Course rosters of students were even shared and confirmed between the Student Success Coach and facilitators before the start of

the semester. The root of the problem was that passwords to access these accounts had all been emailed to the student's Purdue email accounts, and the students were not aware that they needed to set up their email accounts.

After all students had proper access to the LMS courses, the focus shifted on providing supports and scaffolding to retain as many students as possible while also counseling out students in time to protect their college GPA. Facilitators expressed concern before the school year started about what this might look like.

I think it might be tricky if we have to have conversations about whether or not a student should be dropping the course and how that conversation might happen.

It's just was such a busy day, I don't see that happening during class. So I'm trying to figure out how, how would we arrange to reach out to that student? I don't want to do it completely over email It wouldn't, I think, convey the nurturing and the conversation that that would need.

As the year went on, both teachers and the Student Success Coach were able to meet with multiple students who were either making the decision to withdraw from the course or were being administratively removed. When asked to reflect back on why students decided not to continue the course, there were a great range of responses. One teacher noted "I think some students just kind of kind of gave up or threw in the towel." Another teacher shared a similar comment "We had a few drop because of grades and I think of those it was like pretty split, like two sophomores, two juniors." When pressed if students felt overwhelmed by the rigor of a college course, the teacher responded "I don't know if it was a rigor issue. I think it was just a is I'm a high school, I don't really feel like doing all this homework."

The teachers shared that while one student dropped the course after contracting Covid-19, other students felt uncomfortable with switching back and forth between face-to-face and online versions of the course. One teacher reflected on a student who withdrew after their parents decided to have them finish the semester remote: "I think he's decided that his schedule is too busy, and he was going all digital and didn't, I think, he didn't think he'd thrive without having some in person [experiences] with this class."

Some students who dropped were only enrolled in the high school side. One teacher commented that even though the students liked the course, getting credit for it was more important. "I know we had one drop at the beginning just because they didn't get admitted to the

Purdue side. They just wanted to wait.” Not all students shared this mentality, especially those that started the course for college credit. Another teacher reflected on one of their students:

We had some who weren't in it for credit, who stayed in it, and absolutely loved it. I know one student in particular, she was one that was forced removed, just to protect her grades and GPA. She was very stressed and worried about her grade at the end, and overwhelmed by the amount of like, assignments that she had missing and needed to turn in, and I think she was also stressed thinking about the checkpoints and getting it all ready for the checkpoints. I just reminded her like, ‘Hey, you don't need to worry about the checkpoints, because you're not in this for credit anymore.’ But I think she in her mind was thinking, ‘Well, that's true, but I want to make sure that I have it all revised and done really well. So that when this is offered again, I could take advantage of just submitting my work, not having to do the class again, and then getting the grade’ because she realized that it was just a lot of work.

A third teacher had convinced some of their students who did not qualify at the time for dual credit to push themselves and stay in the course to try to qualify for credit through a CLEP exam or portfolio submission after matriculating to Purdue. They reflected on their student's performance, “The two kids in my class that are not taking this for credit are probably two of the better students in this class. They should be eligible to get the credit for it, they gave as much as anybody.” They went on to say “If they if they do well, with this class, I'm gonna fight tooth and nail for you to give them credit.”

Teachers with students who performed at a high level were encouraged to keep record of grades, feedback, their design journal, and other evidence of success to effectively advocate for their students after graduation.

Teacher Involvement and Engagement Outside the Standard Curriculum

It was apparent that teachers dedicated many hours into scaffolding and supports for their students to raise them to a point of success at the end of the course. Throughout the semester, teacher created both supplementary materials and documents to keep students on schedule to meet the required checkpoints. When asked about their involvement and time commitment, one teacher made a comparison between the mentality of college students and high school students “I

don't see from your vantage, you know? I don't have college students, I have high school students. So pushing them is horrendously important.”

Some teachers found themselves emailing students outside of class to reemphasize the importance of due dates for assignments and checkpoints “I send a couple emails during the week to let them know what's due. It's due and this is what you need to have done.” Other teachers reached out to parents as well as students to encourage assignment completion and success “We've I mean, we've had students not turn [assignments] in, but I feel like we've reached out to parents and you know, had talks with them and kids.”

Teachers were encouraged over the summer to adapt the curriculum to their classroom and environment and make whatever changes they saw fit to the lesson delivery to help the students make sense of their assignments. One teacher reflected on how they wanted to see the full curriculum in its entirety first, “I like to feel like I'm still giving a class that the students at Purdue are getting, or at least that I don't feel confident yet enough to change it more than some of the details of the class.” They went on to talk about how they only felt comfortable changing the wording of some assignments that used terminology such as ‘campus’ or ‘major’ specific to on-campus students, “I feel comfortable saying, Oh, just look at that from the your interests or from your neighborhood, or whatever makes the most sense for the individual challenge.”

Some teachers felt emboldened to make much bigger changes to the lessons and materials. One teacher created an extra exercise to share with not only their students but other teachers as well (see Figure 33) “The first lesson that included [a decision matrix], [another teacher] was leading it. And so they had created their own example chart, and that was really helpful to see.” When asked about the example found in the curriculum for this concept, the teacher noted “The examples we saw in the lesson with the Purdue co-rec building, I don't think that that one was very relevant to the students. So I built one that they were able to understand the difference between constraints and criterion.”

- Explain the terms “criteria” and “constraints.” Criteria are things the design needs to do in order to be successful—its requirements [Think Design Requirements!]. Constraints are limitations on the design. These may be materials available, the cost of the materials, the amount of time they have to develop the solution, etc.
- Example on next page.

The Challenge

HOW HIGH CAN YOU GET THE MARSHMALLOW ABOVE THE TABLE?

(USING ONLY THE MATERIALS BELOW)



20 sticks of spaghetti + one yard tape + one yard string + one marshmallow

***THINGS CAN ONLY BE CONNECTED TO THE TABLE. FOR INSTANCE, YOU CANNOT TIE THE STRING TO THE CEILING OR WALL. WE WILL MEASURE FROM THE TABLE TO THE MALLOW.**

YOU HAVE 18 MINUTES

- Examine the marshmallow challenge. Discuss the criteria and constraints for that challenge.
 - *Criteria for success: The structure had to be free-standing, stable, as tall as possible and hold a marshmallow at the top.*
 - *Constraints (limitations): Students could only use the materials provided—spaghetti, string and tape. They had 18 minutes to build their design.*
- Discuss and look at multi criterion examples from the reading & briefly discuss. Highlight the following:
 - scores given, specific details & measures of criterion

Figure 33. *Teacher-Created Supplementary Materials to Aid in Teaching Criteria and Constraints*

Other teachers felt that presentations were needed, not for in class assignments, but to help students connect more with the prep work before each class, “I would definitely do the slides. You know, just to give them previews and help them to understand so then when they actually read the material, they have more understanding.” Another teacher made a similar comment, putting emphasis on how weekly meetings helps support their lesson planning:

What I think something that is working right now is I've been making presentations, and some of it is based on Brightspace, some of it's based on your notes from these meetings, and the students are liking that. Because it gives them

a little bit of a projection. So my last slide is always a projection for the next lesson so they know what to expect.

Using materials provided in weekly meetings with the university to help with planning was a common theme across teachers. One building of teachers even went so far as to modify and share the meeting notes with students instead of using slides:

Another thing I would continue, is probably the kind of the newer way I've been putting my lessons together just as a Google Doc rather than slides. Like the slides that I put together before were great, and nice and, organized, but just the editing, formatting and beautification of them alone could take about an hour and time is very, very precious. So we discovered that, hey, if we just share, like, project a document up on the screen, then we can share that document with students after we go through the lesson, and they're working, and that's much easier for them to refer back to as well. They know what the agenda is, versus the examples we've gone through, versus here's what to focus on now rather than having to click through several slides and find it.

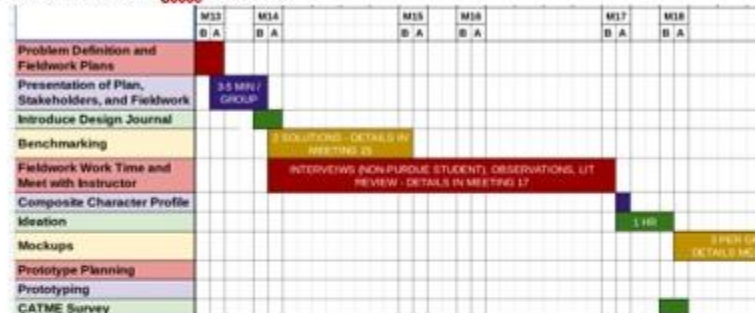
They went on to clarify what this looked like for students (see Figure 34):

I even just cut out some of what was in your agendas, and just walked them through items that you had already written on our agenda that you walked [our school] through. I just removed anything that was confidential that they didn't need to know or see.

IMPORTANT DATES OCT 20 – LAST DAY TO WITHDRAW FROM COURSE WITH W OR WF

1. Today:

a. Where we are in the gantt chart below



2. Announcements

- October 20 last day to solicit voluntary drops or conference with students
- Class time and team meetings are not the time for you to be completing work you did incorrectly or did not complete on time. It is not an effective use of time and wastes partner's time. Save that for out of class time and focus on the tasks at hand or you will get further behind. If we say you can use class time for an assignment, then it will be okay, but if we did not say anything about you doing or fixing an old assignment, do not use our teaching time nor your team collaboration time to fix your own work that w

3. Lesson 15 In-Class - Multicriteria & Benchmarking

- Lesson 15 Prep for Class
 - Peer Insights – Team Planning (3:00)
 - Multicultural Analysis Reading (7 pages)
 - Most focus on pgs. 8-9
 - Tips on pg. 10
 - Benchmarking Assignment (Individual)
 - Same as in Project 2
 - Make copies as needed in Design Journal
 - 2 Solutions per student
 - Constraints and Criteria for each student's favorite solution (multiple/group)

Figure 34. Modified Agenda for Lesson Planning

Other teachers used information from the meetings to communicate with students outside of class:

As soon as we were done with our meetings, I drafted a summary of our meetings, and I blasted that out to my students, and then I would send them a couple more. I would take the areas within that week, and I would summarize those sections and blast it out to them so they always knew what to expect. They always knew what was coming. And they, I mean, if you don't know what work has to be done then you don't know how to prepare for it.

One teacher expressed that weekly meetings and support made them feel more connected to the dual credit course, and it would seem the students also acknowledged the impact their teachers were making, as the teacher shared “I feel connected to you and your program, and one

of my students wants to go into teaching now, who is in this class.” Teachers acknowledged that while creating slides, sending emails, and modifying lessons was time consuming and beyond what was required, they were passionate about doing what they could to increase opportunities for their students.

Teachers’ Proposed Changes for Future Iterations

Throughout the semester, teachers were encouraged to be reflective about the previous week and note what went well, or potential changes to address problems they had along the way. As it is often difficult to make a strong recommendation before seeing the whole picture, these were summarized and reflected on again at the end of the semester to note changes in attitude and responses.

One category of change was teachers reflecting on their own practices in how they delivered content and approached curriculum. One teacher found that by only focusing on the delivery of materials, they had a difficult time making connections to the content. Once they started reading the prep work for class, they were more confident, “I did the pre class work just to see what it was and to see what it was like. I felt like that helped me have a little bit better context of how to teach the material.” Another teacher focused on how a change in grading practices to mark assignments missing while still providing the opportunity to submit at a later date may impact student engagement:

I was thinking that one of the things that we might need to adjust as teachers is our grading. In the past, I've been like ‘Oh, that's turned in now I'll grade it.’ But if we can get in a habit of marking things that should be turned in, we need to communicate, ‘Hey, I still want you to turn this in, and I can grade it.’ But I think that giving them the feedback that it should be in might be beneficial.

Similarly, another teacher talked about changing their approach in similar courses based off of their experiences with Tech 120. “We were talking about this yesterday, and like, we've just got to change some things to make this a little easier for our kids, because I feel like we're breaking some bad habits that they have now.” When asked about what kinds of bad habits, the teacher went on to list, “It’s partly turning assignments in, it’s partly it's just how they research, it's partly how they interview. If we have the system in place then we can make this so much

easier.” Continuing the idea of ‘good’ and ‘bad’ habits, another teacher talked about adjustments to the pacing of the course and where they placed emphasis:

I think that now that we kind of know the whole course, I see those first two projects, as seen if maybe we change the curriculum of those first two projects, because it's for them, it's more of a bridge from what they've been doing, and a retraining of them habits. I wonder if we would get the leeway at that point to say, all right, our project three is the same, same expectations, but maybe we tweak our schedule for project one and two for specific skills that we see our students needed.

Another category included changes that were simple and straight forward enough that they could be made in the middle of the semester. Wording on assignments, instructions, and rubrics for example, were sticking points for some students. One teacher shared “Verbiage is, is college verbiage, as opposed to high school verbiage. You know, like when we talk about things like majors and being on campus.” Another teacher pointed out an assignment where “the last sentence just said, read the rubric, and there was like that whole other text evidence thing that wasn't in the directions, it was all in the rubric.” While it turns out that the instructions did indicate to use evidence to support statements, it was not prominently featured, and was only at the top of the page as opposed to being emphasized with each question.

While the previous suggestions were immediately changed, they were reactive and did not impact the student or teacher experience of the course. An example of a proactive comment that was immediately implemented was modifying the agendas used in weekly meetings to include important dates:

Registrar related things, like when they can drop classes and the timeframes of that. If there could be a list of those specific dates at the top of these agendas each time so we can be reminded of that, that would be great.

This change happened early into the semester, and not only were these dates communicated weekly with teachers, but teachers referenced back to them throughout the semester in communicating with students as well.

Not all suggestions could be easily changed or immediately acted on, but were noted as changes for the following year. Multiple teachers expressed difficulty in navigating the Implementation Plan. The Implementation Plan was a live document with weekly notes from

meetings with Purdue instructors between each of the meetings, as well as suggestions for edits and changes to the course that proved to be distracting to some, as one teacher noted “If that sketch plan had been a little bit more easily correlated to the actual lesson plan within Brightspace, it would have been easier for me, instead of notes everywhere.” Another suggested condensing the Implementation Plan into just the lessons, or ready-to-go slides “I would have liked to have a presentation of basically what your meetings are, which is what I give the students, those previews.” Another teacher added:

If I were going to teach us again, I want a set of slides. Your plan, I think some of it's kind of ambiguous, it's not direct enough for me, so I would definitely do more slides because our students need a little bit more direction.

This prompted another teacher to comment, “I wholeheartedly agree. If we had a set of slides to work from that would be amazing.” When asked for the level of detail that lesson presentations should have, one teacher offered “In every assignment, on the slide, I would put the rubric, because they're not turning in what the rubric says. [I have to remind them, and] they resubmit, and it causes me to grade two and three times.” Teachers’ concerns and suggestions were documented and shared with the research team.

4.3.2 On-going Support – Identifying Barriers

Many barriers were identified in regard to the course implementation. These included some topics that impacted the study due to timing are beyond the researcher’s control, such as teacher moving to a new school building or complications due to Covid-19. It includes topics that will continue to be ongoing considerations, and should be planned for, such as student homelife, student readiness, and teacher confidence. Finally, the last theme of barriers are ones that lend better to modifications and adaptations, such as course assignments, complications with the LMS, communication, and scaffolding.

Barriers Due to Timing

In investigating the ways in which professional development and ongoing support meet teacher needs in a facilitator model implementation of a dual credit course, it is worth noting that the needs during Covid-19 were beyond that of a typical school year. One of the schools the researcher worked with moved to a new location with two buildings on site. Teachers that

typically saw each other daily found themselves in a situation where they were in different buildings on the same campus.

The much larger disruption stemmed from the regulations around Covid-19. Students across the school were split such that they were face-to-face for instruction twice a week, either Monday/Tuesday or Thursday/Friday, did not meet on Wednesdays, and were virtual for the other two days. This further disrupted teacher-to-teacher communication, as some teachers were not on the same rotation, and thus never shared the building with the other teachers, or the students from the other classes.

Having students face-to-face two days in a row was also a challenge. To parallel the university schedule, the high schools decided to complete two lessons each week. In a normal school year, this would give teachers Monday and Wednesday for guided prep-work with the students, Tuesday and Thursday for the lesson, and the fifth day for scaffolding, supports, and feedback. Because students were reduced to a four day week with two consecutive face-to-face classes, teachers gave up one of their face-to-face classes to complete prep-work, and lost a day for scaffolding and supports.

One teacher had to quarantine after flu-like symptoms, while another teacher contracted Covid-19, and had to combine their classes with another teacher to finish the school year. A third teacher lost a quarter of their class for a period of time after all of the students from one gym class with a Covid-positive student were quarantined, and all throughout the year students would be quarantined at random times forcing them to attend class virtually while their teammates attended in person. Part way through the year the school went to all virtual classes, causing enough stress and anxiety for some students that they withdrew from the course.

Covid-19 also presented complications with assignments where students were required to sit in a public place for observations, or for the scaffolding that would normally take place when preparing students to conduct an interview. The researcher was able to offer some supports to teachers in the weekly meetings by modifying assignments and providing solutions utilized by the university, but there is no question that Covid-19 impacted the outcomes and morale of the students and teachers.

Ongoing Considerations

College students and high school students, while similar in age, are very different in circumstances. Teachers made a number of insightful and valid points throughout the semester about the expectations of these two populations:

I think the other hard thing is just the expectation that kids are going to be able to see each other outside of class, you know? We just have to assume that's probably never going to happen. There's no 'Hey, meet me at my dorm.' There's no 'Meet me at the library.' These kids go off and they're in their own world. College kids generally don't have babies at home, siblings to take care of, or, you know, I know they work, it's not that they don't work, but you're in more of a bubble there on campus than our kids are. So that's the hard part. And I kept pushing them to do that, but the truth is, it's nigh impossible to get them to meet outside of class.

To make matters more challenging, as these were both high-needs schools, students faced a variety of circumstances that provided extra barriers. One teacher reflected on a set of assignments that required students to conduct a twenty (20) to thirty (30) minute interview. This would typically be done outside of class, and may be done on phone, online, or face-to-face. The teacher commented how this may present extra challenges based on their observations of teaching students virtually, noting "It's often hard for these kids to have their mics on at home because of all the chaos going on in their lives at home, and so phone calls probably make it just as complicated." While reflecting on their students, another teacher shared "One of [my students], didn't speak English, so I think that was particularly tough. Another student is the one that sticks out [to me] the most like, she was just overwhelmed with everything in her life." They went on to describe:

College freshmen, taking Covid out of this, get to move on to campus and live in a dorm and don't have to worry about where the food's coming from, or whether or not the light bill is going to be paid, and they have a place to stay. Sure they have their drama, whether or not they get along with their roommate or whether or not they get into the sorority they wanted, but they're not babysitting. Right? They're not worried about how to get to school. Our kids have that. They're essentially non-traditional college students with lives. I think that makes it harder for them.

These circumstances impact students' attendance at school as well. Another teacher went on to describe the complications that came with teaching a class of seven (7) compared to a university class of thirty (30) or forty (40) students:

I think that one of the most challenging things is just like, making sure they're there every day. Like in college, you're pretty much expected to be there, right? I don't know, if you take attendance in class, but you know, which kids are there, and if they're not there, you're like, well, you should have been here for class, I can't help you. Whereas our kids have 100 more reasons why they may not be in school. Like, it's pretty frequent that I don't have a full class. I mean, I may have one missing from every class, and when that happens, you're letting down your teammate. That is also when you only have seven kids in your class, that's one seventh of your class that is not getting the instruction!

Many comments revolved around student preparedness or readiness to adapt to the requirements for the course. Many teachers shared comments revolving around timeliness and assignments, it was common to hear "For some, independent skills are sort of lacking you know? If we asked them to do something outside of the regular time just being able to rely on it getting done." Another teacher shared "I have students, and they're good students, but they have no urgency." Teachers often attributed this to common grading practices at the school focused on mastery learning and student supports that tend to clash with more rigid university practices. For example, the high school allows student to learn at their own pace such that individual students meet learning targets faster at some parts and slower on others, which did not align well with our course structure:

You know, we tell them that, 'Hey, you can work on geometry for the next two years, there's no timeline as to when things have to be done.' And then all of a sudden to find out you have to do this *today*, like this is *due tomorrow*, you *have* to turn this in. You know? I think that was a bit of a culture shock.

Another teacher was quick to point out that while true for many students, some students embraced the deadlines and expectations, "And this isn't true for all the students, some of them did a really good job. And I was impressed with them getting the material done on their own and getting these turned in." A teacher at a different school shared a similar experience with the success of students that worked outside of class:

I think there were maybe three teams that really stood out among the others, where they like, spent a lot of time outside of class and had really polished projects. And one had a fairly polished like skit in front of the class. And I was just really impressed with the work that they had done there.

One teacher noted that some of their students were overwhelmed with the assignments and expectations for the course, as well as the fact that there would be deadlines for submissions at each of the checkpoints. Assignments accumulated, and by the first checkpoint they had decided to withdraw from the course. “We had some students who were in it for credit, but they were intimidated. So we might have lost one or two students early on, because they're intimidated by the amount of work.”

Task completion issues surfaced in prep work for the course as well. Many students had similar experiences and assignments in other high school courses. This acted as a boost in confidence, as much of the work felt familiar, but some teachers worried that it could also lead to neglecting the prep work throughout the year for each lesson. One teacher reflected on how previous design courses provided just as much of a barrier as a support:

When we debrief the homework, the thing I've been trying to wrestle with, is how do we do this the best? Because, honestly, they could probably not do any of the readings in here. We're talking about prototyping and being able to contribute to the conversation. So it's like, because they've all have a lot of prior experience with a design process. You know? It's not they haven't done a PoV statement before, but they've done problem statements before. So I guess [what we are trying to differentiate] is if they're relying on the old way they did it, or if they're using the new way. I think that'll just continue to be where we hone in on our teaching. Like, here's the difference from what you have done to what you're now expected to do.

Student readiness, especially as it related to task completion, was a major identified barrier that resulted in some withdrawing for the course. Some students expressed doubt in their ability to keep up with college-level work, but many students successfully completed the course with the support of their teachers. It is interesting to note that some of these same teachers that provided multiple points of scaffolding, expressed similar doubt in their ability to facilitate the course with fidelity.

While the summer session gave teachers a broad overview of the course, learning targets, and target outcomes, teachers only experienced six (6) of the twenty-six (26) lessons they were expected to teach. One teacher commented after a few lessons that they struggled seeing the big picture of the class because of “not having taken the class and not writing the syllabus. “They went on to say, “I like it more than I can express well, because I want to do this with fidelity, and I want this to be successful. I mean, I’m very committed to this. I just, I just feel lost.” When asked what kinds of supports may be helpful, they responded “Half the time I don’t know what I need from you until I need it. You know? I mean, a year from now this will make sense because we’ll have done it.”

As the semester continued, the teacher’s comments reflected an increased sense of confidence. In an individual interview in mid-October, they remarked:

I’ve been thinking about this a lot, like, I feel pretty comfortable with the class, now that I’ve done it, but man, just getting to that point has been so hard. You know? I feel like I could teach this next time, next year, with no problem.

Some of this confidence was attributed to weekly meetings, as multiple teachers noted the reassurance they received in implementing the course with fidelity, “It just helped me like, be reassured that how I was interpreting the Implementation Plan was how it should be interpreted. It was just like reassurance.” Another teacher made a similar comment about the weekly meetings, reflecting “I think it gives me confidence in some things that I might otherwise feel unsure about.” Still another teacher spoke on how the meetings brought clarity to topics that they may have overcomplicated, “My understanding of the implementation schedule, and material have looked way more complicated in my mind than how you describe it, and that just simplifies it. I appreciate you doing a brief walkthrough of the lesson. It helps with planning.”

Other times increased confidence came from having the opportunity to take the lead on curricular decisions with other building teachers “It was nice to have the opportunity to be in places where I needed hand holding, or pulled along, and other times I could say, ‘Nope, this is how we’re doing it’ and I can pull other people along.” Still at mid-semester, the teacher expressed “I don’t have a deep enough understanding yet, that I feel super qualified to be doing this. And I know that’s going to come with time.”

By the end of the semester, teacher comments reflected large gains in confidence. One teacher was already looking forward to the next fall, remarking “I think for me, the big thing is

going to be next year, you know? Like having walked this path for the whole semester, the next year will be so much better.” Another teacher commented on how well they adapted to teaching a new curriculum over the semester:

I think that it's been cool to see how quickly and easily like, we've both adapted, and then just me being familiar with like the Purdue model, and [the other teacher here] did not go to Purdue, and just seeing like how quickly they just fell into naturally, like, leading all the lessons that they lead, and knowing how to lead it, and aligning with Purdue values, has been really cool to see as well.

At the other school, one teacher had to quarantine after contracting Covid-19, combining their class with another teacher from the school. This resulted in a positive experience for both teachers. The teacher leading instruction, who had struggled at points throughout the year in feeling confident to teacher the course with integrity, now commented “The last two weeks or so, getting to have their class be with my class, I feel like, 100 times more productive and better as a teacher. That's why having eight kids in the classes is almost too small.” And going on to state “I still want to know this better than I do now, although, I feel a whole lot better, you know, lesson 25 than I did at lesson five.” The teacher who was quarantined also shared their experience watching remotely as the two classes combined, “I love tag teaming with somebody, you know? They come in with a different perspective than me, and it was fun being in there, listening to them, and being able to chime in with things that are important to me.”

Moveable Barriers

The barriers introduced so far have been beyond the scope of the course, but several themes emerged throughout the semester that the implementation group have some control over. At the start of each weekly meeting, teachers would reflect on assignments students may have struggled with. One of the unexpected barriers was a result in the phrasing of instructions, as one teacher commented:

They get really hung up on words like *paragraph*. ‘What is a paragraph? Is that a paragraph for each question?’ And I'm like, ‘I think they just mean, you know, it needs to read like a conversation.’ ‘Well, how long should it be?’ You know? And I mean, I think it's one of those things where the students do want to please, but they don't necessarily know how.

Another teacher was focused on campus specific language used throughout the assignments.

I think the hardest part was some of the content for them isn't necessarily accessing it, it's being that the content is straight Purdue content. It'd be nice to pick through this and change the wording of some things from 'your major' to, you know, 'your interests' or from 'campus' to 'your neighborhood' or whatever would make sense to them.

Students seemed to be very aware of the benefits they would receive from successful completion of a dual credit course. Teachers shared that they reacted with a sense of anxiety for responding with something other than the prompt, even after being assured it met the intent of the question.

Other struggles included content specific barriers such as interviews and source evaluation. For some students, previous experiences in similar coursework led to overconfidence and overlooking rubrics and instructions:

They thought that it felt too familiar. I mentioned this yesterday, what I would like to do is I would like it to be even a little more familiar in a way that that stairsteps, because I think they thought things that weren't true. Like, we saw that they don't know how to do interviews. We saw that they think an interview is an email with no back and forth.

As predicted in the professional development, finding people to interview and setting aside time for conducting interviews was difficult for students. One teacher shared with the group, “Our students maybe could use some support with either dedicated interview times or support in connecting with some people for their user interviews.”

Similarly, source evaluation, another concern that teachers had over the summer, and triangulation proved to be challenging to the students. One teacher commented on the “That real level of research and the triangulating from the different points of view, getting them on board with APA citations, and the rigor of documentation interviews. All of that, I think that is the hardest thing to translate for them.” This was true for students across both schools, as another teacher commented “I think the students probably need the most support on the source evaluation. Like, triangulation for the first time, that was new.”

Another barrier regarding assignments was the amount of time it took for students to complete the preparation work for each lesson. To help students estimate how much time they would need to allocate outside of class, each lesson was preceded by a checklist and time estimates in the LMS (see Figure 35). This could be especially frustrating for students if it took them substantially longer to complete these assignments, as explained by one teacher:

Sometimes the pre class work is taking them like three to four hours instead of an hour, hour and a half. I think some of that could be that they're not completely focused. The other part could be that, because it's a little bit higher level of knowledge, it takes them a little bit longer to have to like, retain it and break it apart, and they might go through it a little bit slower.

L11 Prep for Class

All class preparation work is estimated to be less than 1 hour.

Upload / Create

Existing Activities

Motivation = Expectancy and Value (1.5 min video)

Web Page

What - Watch 'Creating Storyboards' (1 minute)

Web Page

Feedback - Lesson 11: CATME Calibration (5 minutes) [Before Class]

Web Page

Apply - Lesson 11: Project 02 - Solution Demonstration (30 - 40 minutes) [Before Class - Group Submission]

Assignment

Figure 35. *Time Estimations for Preparatory Work*

The LMS was another barrier. Another of these barriers that can be accounted for is the LMS Brightspace. While the intention of having the teachers as facilitators interact with Purdue's official course shell, this also caused several complications. One teacher noted that navigating between the two Brightspace course shells was a little overwhelming for students to get used to "The second Brightspace having a different login for them, it was a lot for them to do independently, and a lot of them weren't able to like handle that. I just remember it took like four class periods." Another teacher noted that especially at the beginning of the semester "They felt were like they had their Checkpoint 1 ready for, I think two weeks? And then just with like, login stuff, they still weren't able to sign in." Going on to say, "I think getting used to a new learning management system was probably the biggest challenge." It is worth pointing out, however, that teachers indicated they would rather provide extra supports than do away with the LMS course "The big challenge is getting them logged in, obviously. Working through ITaP and all that is yes, though, and you dealt with most of it, but I think it's worth it for them to feel like authentic college level students."

Having two course shells for the students that were taking the class for credit also caused some confusion early on. Some made the assumption that they would use one or the other, not realizing that the college shell contained no information, instead it hosted four checkpoint submissions. This misunderstanding was discovered when one teacher shared "That's one of my frustrations, I don't see what they see. So, I'm like, 'Okay, do this, do this.' I'm like, I'm totally prepared. Here's all this and they're like, 'I don't see that.'" Other dual credit students were confused about where to submit assignments, not realizing that they should submit the material to the curriculum side first so they can apply suggested changes from their instructor before submitting it to the side for college credit. One teacher was frustrated with this, stating "I didn't get a chance to review all their work before they finished it. They were so far behind, and some of them still haven't shared it with me! They shared it with you, but I still haven't seen it." It should be noted that the confusion with Brightspace and where to submit assignments was only found in the first four weeks of the course, after Checkpoint 1, but before Checkpoint 2.

As teachers navigated the curriculum, they provided a number of supports and scaffolds to retain as many students as possible. At multiple points in the curriculum, this took the form of extra time on assignments to provide differentiated instruction. One teacher discussed how they modified the timeline of the first project, providing an extra day because "The writing the PoV

statements as a group, just, they were really meticulous so we gave them some extra time the next class period to do it.”

In other instances, the teachers felt that the prep work was not enough for their students to be successful, even if given more time, and provided extra steps to strengthen their work. One teacher shared “I just needed to give them more examples. The directions I will say per the that Google doc and Brightspace, they are not always clear what to do.” When asked for specific example, they shared “Like PoV statements. They needed a lot more guidance on how to actually do them. I went to a lot of different websites and gave them and showed them different POV statements from other websites and how they did it.”

Another teacher found that discussions helped students differentiate new material from similar, previous problem-solving experiences in other courses. Worried that students may push back against coursework that may be too similar, the teacher would encourage students to share:

‘Oh, you know, this is kind of like when we did ‘bla bla bla bla in [another course]’, whether it's the person saying that, or the rest of the class getting to hear that, and it helps. I think that's just been helping everyone reflect on how things are similar and different and just preventing any type of pushback.

A teacher at the other school shared a similar experience, reflecting on the fact that students have seen similar coursework:

Some of the skills that they've developed in some other classes, it felt a little bit strange, sometimes presenting them as new, but I also knew that some of the things within those skills they needed to level up. So, I don't know, I think if I did a couple of the lessons, I might try to do a, ‘Okay, you've seen this before, I want you to do it.’ But then when we come back, I would say, ‘Okay, how can we be better at this? Here's a technique.’

Not all teachers felt that they could provide adequate supports for their students, as they were still grappling with the bigger picture of the course and how much extra time they would really have. One teacher acknowledged that while they didn’t feel comfortable providing supports this year, the experience of teaching the course in its entirety would build confidence for helping students next semester:

I think if I were to be teaching this a second time, I'd be better prepared for some of the scaffolding and I would be less concerned with 'Am I delivering this lesson

as it should be?', and be able to know. It's hard to both teach a lesson for the first time and provide scaffolding for the struggling students. You're kind of caught up in delivering the appropriate lesson so it's harder to step back.

While many potential barriers to implementing a dual credit course surfaced throughout the semester, teachers developed solutions or offered suggestions to overcome them in future iterations. These solutions and suggestions were documented and shared with the research team.

4.3.3 On-going Support – Provided Supports

One of the advantages of the facilitator model is the level of support that can be provided to facilitating teachers throughout the school year. In this study, the Student Success Coach met with each school for one hour each week, providing multiple forms of support. This includes administrative support with the learning management system, student communication, and other communication. It includes academic support, offering exemplars and feedback on grades. Finally, it includes curricular support, offering help with the Implementation Plan and modifications to the curriculum. This section also includes teacher's response to weekly meetings.

Administrative Support

Even though teachers interacted with Brightspace throughout the summer, adapting to a new learning management system for just one of their daily courses can be challenging and overwhelming. The researcher was able to share multiple strategies with teachers throughout the year as they became more familiar with the basics. These strategies include ways to group and sort students, how to download and upload the gradebook, and how to navigate discussion boards and create new topics. Other administrative supports included embedding the Implementation Plan into an 'instructor only' section of the course shell, and tracking student participation in preparatory work.

Some features of Brightspace were not intuitive, such as assignments for group work. By default, group assignments are not visible to students until they sign up for a group. This can lead to confusion, as neither the instructor view nor the 'View as Learner' mode show any indications of a problem (see Figure 36).

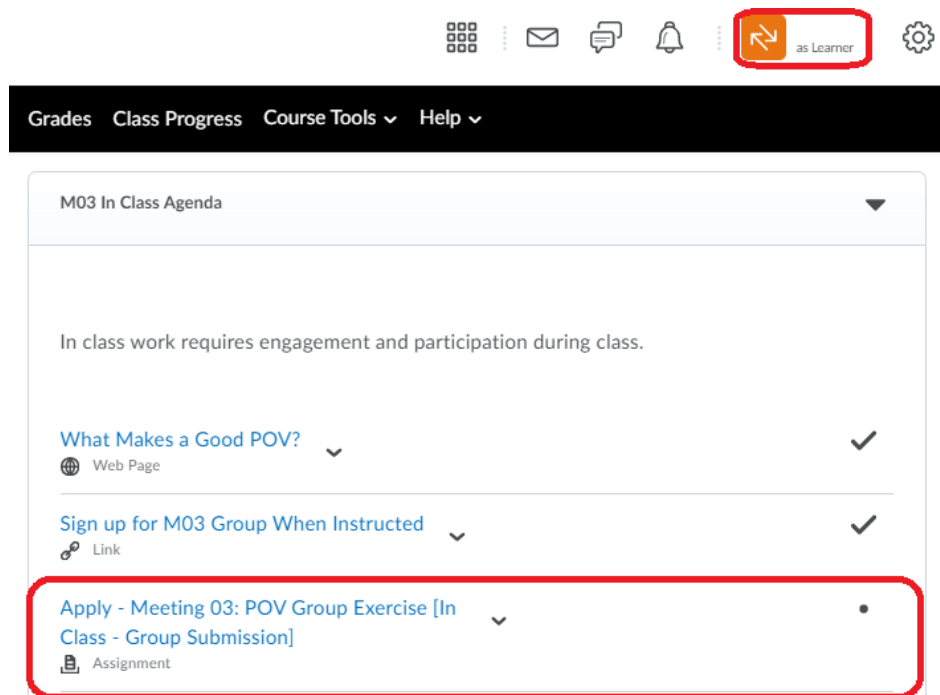


Figure 36. *No Indication Group Assignments are Hidden from Students*

Other features, such as the gradebook, could be misleading as late and missing assignments were not auto populated. A teacher would have to manually enter zeros for missing assignments, as described by the Student Success Coach:

So like, here, this person didn't do the quiz, they should have a zero there. Okay, so any of these where they never turned in those assignments - This person may have had an 'A' at the start of this, but as I'm looking through, she doesn't have any of this turned in. So, what the student sees is that they didn't turn something in but they still have an 'A' or 'B' in the class, they must be doing fine. When they go to turn that in as a checkpoint, they still don't have those assignments, and all of a sudden, they have a 'C', or a 'D', or an 'F', and they may be surprised by that.

Similar proactive conversations took place throughout the year to support teachers in adapting to a new learning management system.

Other administrative supports included communication with students from the Student Success Coach. When setting up the course, all students who were interested in the Design Thinking in Technology curriculum were encouraged to apply to Purdue for dual credit, but only

63% of students that applied were accepted. As checkpoints were designed in such a way as to remove dual credit students from the college portion of the class and still gain the high school credits, the decision was made to allow students who were not admitted for dual credit to complete the course for high school credit. While this may seem an unusual decision, this teacher describes what it meant for the confidence of non-credit student participation:

We actually had our non-credit students, even though they're not taking it for credit, they're still equally eager. They asked us if they could still find a way to submit their check point one even though they're not taking it for credit, because they just want to know like, 'Oh, is my work like college ready or is it not?'

It was often the case that students were denied participation due to a GPA that was negatively impacted from poor performance in courses early in their high school career. Students had matured, improved, and were eager to see if they were ready for more of a challenge. The Student Success Coach allowed these students to utilize their email to submit and receive feedback on their work.

The Student Success Coach was invited to teachers' classrooms and building level discussions with students multiple times throughout the school year. Topics varied from feedback on checkpoints, to expectations for projects, to just answering questions. Even though teachers could answer these questions, having them answered from someone who was grading their assignments for college credit helped to lend credibility to expectations. One teacher reflected:

I really appreciate you coming in today to talk to them. That helps. They just want to know what they need to do. They, and my students, they want a good grade, so hearing from you, and hearing it from me, I just think, you know, you're a higher authority, so it helps them.

Another teacher reflected on students' connection to the university, commenting on how easy it is for students to feel removed from the college environment when engaging in a dual credit class in a high school setting, facilitated by someone students are already familiar with. They explained:

I think it's probably been challenging for the students to just kind of feel, to be experiencing the class in one of our classrooms. To convey to them that this is still, that we are directly linked to Purdue. I think some of the times when we've

done well to overcome that where was when like you were able to talk with them as a class, I think then they say ‘Okay, this isn't just [my teachers] or whatever, this is this is the person who's grading it, and they work at Purdue.’ So, bridging that space is really helpful.

At times throughout the semester, one or two students would have difficulties with interpreting the assignments or feeling confident in their work. Teachers felt comfortable reaching out and asking if the Student Success Coach would virtually meet with these students respond to questions. In one conversation, a teacher who had students that had been unexpectedly remote for several classes and now needed scaffolding to modify group work tasks asked:

So like with [these two students], would it be good, and [Student Success Coach] you tell me too, you know, to actually have like a meeting via teams or Google meet with them and kind of go over some things to kind of pick up a little of that slack? Because I mean, honestly, we didn't plan for that, right? I mean, that's not normally how it's gonna go.

The Student Success Coach met with these students, listened to their concerns, and provided accommodations that would allow for them to complete their checkpoints on time. While the Student Success Coach met with these students from a teacher recommendation, some students advocated for themselves and requested a virtual meeting either to share their experience, or because they were considering dropping the college credit portion of the course. During one of these meetings, a student acknowledged the confidence the Student Success Coach was building for the dual credit students by regularly communicating expectations and providing feedback:

High school and college are two very different things, and I know personally, like, high school and college curriculums and understandings and rules are a lot different. I'm glad that you know, you have this area, because now you can kind of bridge that gap and make it easier on both the high school and the college side.

There were several emails administratively sent, even before the course began, from the Student Success Coach. Topics of these emails ranged from issues with applications, progress in the course, and important deadlines. At one point, midway through the semester, students

responded to a one-question survey of how they were feeling about the course. A summary of this information was shared with the facilitators in a weekly meeting:

This is the email that was sent to the students, and it was personalized with their name, and prompts them to check their current percentage, and what percentage they can finish with. There was also a short, one-question survey, that about nine students have responded to me with, just asking how they are feeling about the class so far. Are they loving it? Have some questions? Or want to set up a meeting about the withdrawal process?

When teachers asked about what kinds of topics would be discussed in the meeting if students were considering withdrawing, the researcher responded:

The main things I'm curious about is what suggestions they have about making the course better, what their experience was, that they've talked to you as teachers about their decision to continue or withdraw, and lastly, that if they are withdrawing that they do it the right way. So, they're making contact with their guidance department, there at the high school as well, so that they don't just stop attending altogether and end up withdrawing from the college course, but having an F from the high school side.

Responses to these emails from students at times unveiled issues of which teachers and the researcher were unaware. One student indicated that they had forgotten their password and guessed wrong enough times that they were locked out of their account. Embarrassed, the student did not tell anyone, hoping to solve it on their own, but was increasingly worried as it was close to a checkpoint. Another couple of students wanted to withdraw, feeling overwhelmed with online courses, indicating that this semester would not reflect their capabilities. The researcher shared this information with teachers in a weekly meeting as well:

I sent an email out to all the students earlier this week and receive word back from one that he's having password trouble, but he's still wanting to submit this work. [These two students] both wish to drop the college credit portion. I don't know if they've made contact with you at all yet, but that might be a conversation they'll be having soon.

The researcher also organized guest speakers to interact with the students throughout the semester. Before the pandemic, there was a day planned for students to come to campus, take a

tour, and meet with other instructors for feedback about their final projects and prototyping plans. As Covid-19 regulations restricted students from face-to-face interactions with faculty on campus, the researcher arranged to have them virtually meet with small teams instead:

If you are interested, we can try and set that up where they can meet with a Purdue faculty member and have 10 - 15 minutes to plan to pitch what their plan is with prototyping, how they're going to test it, what their big idea is and how they're addressing that with their proposed solution.

Part of the students' on-campus experience would also be meeting with a university representative for recruitment and supports when transitioning to campus. It was noted that all coursework was to be submitted by December 4th, but the semester remained in session until December 16th. The Student Success Coach made arrangements to support teachers in lesson planning for these last two weeks by providing a variety of activities for the teachers, including a presentation from the recruitment office. One teacher reflected on this experience:

It did go very well. They covered the information like the majors and stuff at the Purdue Polytechnic Institute, and briefly went over that with the students. I think I told them like, basically, our students love hearing from guests. And they usually take what they say, especially if it's coming from someone currently at Purdue, they take it to have a little more meaning and significance than when their direct teachers are sharing it. I think it was really great, and some students had some questions, and they also went in and covered clubs and student activities. Those are things our students haven't been made aware of, and a few other things. So it went really well.

The Student Success Coach also helped to facilitate communication among teachers in the same building. In one interview, the researcher noted that the teacher was creating extra supports for their students using Google Slides. As the topics of these slides were in-line with struggles other teachers in their building, the researcher acknowledged that emails may be time consuming, but adding a collaborator or contributor to a file may be more manageable. The Student Success Coach went on to encourage the teacher to share their resources:

If there's something like that, where you can just like add a collaborator, without even sending an email, that might be helpful for other people in the group. They're going through the same kind of thing. I think you guys have a good

support network there. Even if you don't see each other, you're all going through the same thing.

Throughout the semester, teachers routinely checked for validation that they were focusing on the right things and giving actionable feedback. One teacher reflected on their communication at the end of the semester.

I was texting or messaging you like, a lot, especially in the beginning, because I do I stress over it. I'm very results oriented, you know? And if I'm not doing, I don't want to find out at the end that I messed up. I want to know, as I'm going along, am I meeting those little milestones? And if I am, I'm totally cool, but it's because I want to make sure that what I'm doing is what's expected.

The last administrative support in this section offered to the teachers, was communication in how to interpret various forms of feedback and reflections used throughout the course. The most notable was a peer comparison software called CATME. Students were prompted to log in at various times throughout their project and complete both a self-evaluation and an evaluation of their team. Scores from this assignment would then adjust the group grades from that portion of the project, such that a team grade of a 10/10 may result in a 9/10 for some students, or 11/10 for others. As this software was only relevant to the last project of the course, it was only mentioned over the summer, with plans to provide support to teachers during the school year when the timing was more relevant. While the software provides easy to read quantitative data, the qualitative data can be more difficult to interpret. Here the researcher explains how to read an individual's scores and offers suggestions on how they might use it in the classroom:

So, what that means is that they rated themselves low, and the other people on their team rated them high. So they are under-confident about their performance. So, you may just pull that student aside and say, 'I just want to let you know your teammates thought you did really well on that last project', something to kind of boost them up. There are other ones who will be overconfident. They rate themselves higher, and their teammates will rate them low, and it flags that kind of thing too. So, these notes are things to look for.

From supporting teachers in using software to facilitating communication, the researcher provided and documented multiple administrative supports throughout the fall semester.

Academic Support

For both students and teachers throughout the semester, grades were one of the biggest concerns, resulting in a number of academic supports offered from the researcher. This included discussions around assignments and expectations, comparisons to on-campus students, identifying when to withdraw students from college credit, and exemplars from previous years to help visualize the end goal.

There was a large focus throughout most of the semester on gradebook comparisons between the high school and the college credit side of the learning management system. This caused some complications, as FERPA regulations restricted what could be shared from the college credit side to non-identifiable feedback from the instructor of record without the context of the student work it was referencing. For some teachers, this was just what they were asking for, as they commented in one of the weekly meetings “I’d love to be able to see like the feedback you’re giving them compared to what I’m giving them.” Comments on why students lost points on various parts of their assignments were copied by the researcher into an email and shared with the facilitator.

Discussions could also be conducted on the high school credit submissions, and the researcher had access to both gradebooks. It was offered that the researcher apply grades to the college credit LMS first, then cross reference the high school side for discrepancies. The researcher described how a discussion about grades may take place in one of the weekly meetings “If there are big discrepancies like that, I can always go in on one of these [assignments] and say, ‘You know, I saw this, you saw that, can you explain to me what you see?’” Teachers were encouraged to read through the rubrics, interpret them as they saw fit, and provide the feedback they felt would most appropriately help each student. There would always be a chance that the college credit gradebook may not match the high school gradebook, but the teachers were assured “if there is a discrepancy between how we grade things, how I grade things, and how you grade things, just tell students, this is a calibration phase.”

Gradebooks between the university and the high school were very closely aligned throughout the semester, but there were some assignments where the high school grades seemed lower than the college gradebook. While some of this could be explained by students making the corrections that teachers left as feedback before resubmitting assignments, it was also discovered that some teachers were using the rubrics in unintended ways. To simplify assignments, most

rubrics are set to administer full points, half points, or no points on any given criteria. The research team demonstrated over the summer that students could earn somewhere between full and half points, or between half and no points, but some teachers were only using the three options. In a weekly meeting, the researcher clarified grading observations with the group:

Notes from grading, it is okay to mark in between, and I think for the most part you are, but these are set up pretty rigid to where they have 100%, 50%, or 0%. Many times, students fall between the two. Just letting you know that it is okay, you're still teaching the course with integrity, to mark a five out of six or whatever you feel is the most appropriate for what they turned in.

When checking for discrepancies between the two gradebooks, the researcher noted that some students had lost points the first time they had turned in their assignment, and lost points for the same mistakes when submitting for college credit. When reviewing feedback left by their teacher, the researcher found it was in-line with the feedback that had been left on the dual credit side as well, the students had simply failed to make corrections. This too was brought up at a weekly meeting shortly after one of the checkpoints. The teachers had a discussion with the students and reported out some time after that they were successful in encouraging students to apply suggested changes. The teacher reflected on the feedback they were providing to students:

I think we are overall giving the same feedback that you're giving; I haven't had any students that have been concerned or asking about that. I think there's one time where they weren't listening to our feedback, and when you let us know that, 'well, hey, I'm grading their corrected assignments based on them listening to your feedback. So, they need to do it.' We told the students that and we haven't had any issues since.

While the teacher was not quite right on how the assignments were being graded, they were correct in noting that students were applying feedback. It was evident in multiple student assignments that their grade was lower in the high school version of the course, and changes were made to strengthen the assignments before being turned in for dual credit, resulting in higher scores on the dual credit side.

Another trend that emerged regarding academic supports was teachers' interest in comparing the dual credit students to their on-campus counterparts. The researcher made several remarks, validating the teachers' facilitation of the course through observations such as "this is

looking very similar to how my normal Purdue courses are that I grade so I'm happy” and “I like that they're actually applying the feedback. You're doing a good job. So, I think that if the students are a reflection of you as instructors, you're both doing a very good job.” It was true that students completing the work to the checkpoints were doing very well. There were, however, many students who found deadlines to be challenging and failed to submit all required assignments to the checkpoint. The researcher noted this too in meeting with the teachers:

Everyone that I've graded, with the exception of some students who just didn't submit assignments, like they had seven assignments to submit, and they turned in four. Well, they kind of tanked, right? So, I tried to reach out [to you as teachers] and say, Hey, this student doesn't have something turned in, please ask them to resubmit with the other assignments. Otherwise, everyone's getting pretty much A's and B's, I don't think I've had too many red flags.

By the end of the course, all students receiving college credit earned an ‘A’ or a ‘B’, with the vast majority of students earning an ‘A’ in the course. It should also be noted that only 60% of students that started the course completed it, as any student earning a ‘C’ or below was removed by the third checkpoint, before it was too late to be withdrawn by university regulations. The decision of when to withdraw students from the course was discussed many times with the research team, and strategies were shared with the facilitating teachers, such as looking at the maximum points available in the course instead of their current grade. The researcher explained this process in mid-September, just after the second checkpoint:

When having students make the decision if they want to continue for college credit or not, don't have them look at their current grades, instead, haven't looked at their maximum final grade. So, if they had a couple of assignments that didn't go, so well. Just check and see where we are at, because this is what's more important, we still have two more checkpoints coming up. And there's a lot more points left for students to earn or lose. One thing that we're going to be checking is that students have at least a ‘B’ for getting the college credit, and that's more to protect their college GPA than anything else, and that'll be at the checkpoint three. Let's come back and see what their maximum final could be, and what you think their progress is so far. We're just going to work with the students to support them as best we can.

The researcher went on to share an example of a student who appeared to be doing poorly on the high school credit side of the learning management system:

Here we have [a student with] a current grade of a 'D' in the class, but their max final could still be an 'A'. So, this only shows where they are at one moment in time, and there's still a lot of points to be had if they get things turned in. So just making sure they know that there's still a chance.

Teachers shared that they used this information to identify struggling students and provided supports and scaffolding to help them finish the semester. It was noted by one teacher that checkpoints and deadlines helped students, but were also cumbersome in their design, sharing:

I think the advantage is it helps them like take it a lot more seriously, I think a disadvantage would be just like the amount of steps that it takes for a student to like, go through all of their assignments, and then re upload them to another spot as one.

Juggling between the two LMS systems proved to be challenging in various ways throughout the semester. These observations were recorded and shared with the research team.

A major academic support theme was student exemplars. Teachers asked at multiple times throughout the semester to see what high quality work at the college level looked like to adequately push their students. One teacher noted that showing students exemplars prior to them submitting their work "Might really help high schoolers see the level of either detail or organization or formatting." Another teacher shared how seeing example would help them in the lesson planning process:

I love examples. Even, when I used to design, I am not great at nothing. You give me something and say, 'Okay, this is what we're looking for.' I look at the specifications and man, I can innovate a lot, but I am not good without knowing where I'm going.

Other teachers felt that exemplar lessons would be more helpful than assignments and were very interested in seeing how the same classes were taught on campus by Purdue instructors. One teacher commented "One thing that I feel like I really need is just more of an idea of what I should be teaching. I would almost be, it would almost be nice to be able to watch some of these being modeled." They were not alone, as a different teacher voiced a similar idea:

Yeah, I think with teaching someone else's course, and granted, I know we want to make it our own in some ways, but this is definitely a Purdue course. That kind of stuff [such as access to recordings of lessons] will really just make, I think, teachers feel better about what they're doing.

Responding to feedback, the researcher provided several examples for key assignments throughout the year. Some examples were specific to how the university adapted requirements of group videos for Covid-19 regulations, as the researcher shared “I want to show you guys an example from the summer where we did the same exercise. So, they had some virtual students and how our still able to make that work. Let's try one more time.”

At other points in the curriculum, the researcher identified articles that would support teachers in communicating key concepts about the course. Here the researcher is quickly summarizing key points from a preparatory assignment to share with students:

There's an article, here, that's five pages. It looks like a lot, but it has some really good examples in there, and here I have it pulled up. So, this is from Stanford Graduate School of Business, but it's specifically about this whole design thinking for social innovation concept. So it's showing the students this is not just a Purdue thing, this is not just a high school thing, this is a much more broader application.

At one point in the semester the school had closed due to Covid-19, and teachers found themselves trying to adapt an in-person groupwork curriculum to a virtual format. The researcher shared lesson presentations and student work created in the spring of 2020 as a resource for teachers to modify as needed at a weekly meeting, highlighting “So along with the agenda for today, I included some other attachments. There's some PowerPoints from lessons 20 on out, and there's also a segment of the student journal, with examples of what lessons 19 and 20 would look like.”

As teachers prepared their students for the final project, one asked “Is there a place where there are, you know, clear exemplars of kind of the end in mind, like I know, we showed in June, we did the PD some like example of presentations?” The researcher was quick to respond with multiple videos embedded in the curriculum, “Yeah, I think in the Lesson 14 prep there's a peer insights with The Door Man video. It's an old Tech 340 solution, about six minutes, and that's a good end in mind solution.” The researcher also found the video shown in summer professional development in a later lesson to share with the teachers, “So that Booster Buddies video that we

saw over the summer with the rocket ship for giving the different shots in the kids' arms at the hospital? That is here, and it's about 12 minutes long.”

The researcher defines academic supports as supports that were provided to assist teachers in providing feedback to students. These were ongoing throughout the semester and included discussions about grading, providing exemplars, and providing lesson examples. These are similar but differentiated from curricular supports in that curricular supports focuses on navigating the Implementation Plan and modifying the curriculum, which are described in the next section.

Curricular Support

While academic supports were specific to grades and feedback, curricular supports throughout the fall semester focused on delivering the curriculum. The main supporting material for the course is the Implementation Plan, a 221-page Google document that is used by instructors on campus. This is a ‘living document’ that contains not only lesson plans, but many other pieces of information, including weekly meeting notes, email templates, and procedures for undergraduate teaching assistants.

Some teachers found difficulty in navigating the pages of the document, noting they felt it was “cumbersome” or that “it didn’t load half the time on my Chromebook.” Another teacher commented they felt it was not organized enough, stating “For me, sometimes the document that Google Doc is so fragmented, it's not like in bullet points.”

Not all teachers shared this viewpoint, as multiple teachers successfully navigated the document routinely. One teacher described how they utilize the Implementation Plan in prepping for each class period “I usually just look over the Implementation Plan and the templates and look over the homework that they're expected to do.” Another teacher commented on how they appreciated the recommended time to focus on each activity:

The first thing I'm kind of focusing on, I go to the [Implementation Plan] and look at, okay, what are the time stamps on some of the main activities? And then I kind of look to the assignments and say, ‘Okay, what do I need to make sure that by the end, students are comfortable submitting or moving on and completed?’ So, I mean, that's been pretty helpful.

These teachers found value in having a guide to outline each lesson, reflecting on how they felt better prepared for each day's lessons "I think everything that's in the Implementation Plan, does a pretty good job of running you through the classes." It was found that teachers may use the lessons exactly as written in the Implementation Plan or use the document as a guide when creating more personalized lessons for their classrooms. One teacher shared:

The Implementation Plan, I usually look at because sometimes there are definitions there or like, here's our focus point for the week. If there's a question or a topic we're going over, you might have listed out like, 'This is what we want to hear from students' or 'Ask this.' So, you give a few coaching tips, and I might pull some of those out.

It was also found that some teachers ignored the Implementation Plan partially or entirely. One teacher described how they use the information found in the learning management system's preparatory and in-class checklist as the primary source for lesson planning, "I mainly look at Brightspace for what the activity is and how to guide students through the in class activity. And any key points from their homework." Another teacher shared a similar strategy, viewing the Implementation Plan as a last resort:

Brightspace got, like, revamped again before the year started, everything that's in there gives us a pretty good idea of what to go over as well. I think what Brightspace does is kind of helps identify the key points of like what you need to go over. And then I feel like the Implementation Plan, like gives you filler content and discussion points if you weren't sure what to talk about.

Partway through the semester, some teachers found themselves looking for ways to save time. Instead of reviewing the Implementation Plan to create presentations, they found that the agendas shared weekly by the researcher contained enough detail to teach from:

I think we realized, like, Man grading takes so much time and all of our other stuff takes so much time, how can we cut some corners here, and still deliver a quality class and content and we're like, shoot, we don't even need to plan lessons. Everything's here.

These teachers still modified the agendas so that only information relevant to the lesson was visible and reflected on how students could more easily find information by scrolling through a page than they could with searching through slides. It should be noted that the

curriculum is iterative, repeating activities and objectives while adding depth and expectations with each project. At this point in the curriculum students had already experienced similar lessons and may not have needed much elaboration to complete tasks and assignments.

As noted, another curricular support provided through the weekly meetings, was previewing lessons and highlighting main focus points and instructional strategies. The researcher would often draw attention to parts of the curriculum that may otherwise be overlooked, as demonstrated here where they identified a section of a preparatory assignment buried under a description of over 800 words:

What I think the more important thing is, it's down here toward the bottom, where they give examples of how you could approach different projects. So, you have value reversal, extreme affordability, and optimization. And then within those you can make this as social innovation or product innovation and they get an example of projects, that would be a social innovation of a value reversal, or social innovation of extreme affordability to show what this could look like. So, when they're coming up with their own ideas, they can, I don't know, kind of break it down or approach it in different ways.

The researcher provided tools, such as Gantt charts, and strategies, such as comparisons to assignments that students were already familiar with to introduce new projects. Here the researcher demonstrated how teachers might walk their class through the expectations of the final project:

I would recommend using the Gantt chart for this. So, if we go back to here, if you just read through this column, this should be very similar to project one and project two, we just go a little more into depth. So, they have the interviews, they still have the benchmarking...

Because the researcher had experience as an instructor of the course, they were able to preview scaffolding with teachers on assignments that on-campus students would typically struggle with. In some cases, the wording or formatting of assignments may result in misinterpretation by students (see Figure 37), as identified here:

It also says on the worksheet to respond to them below and include a plan to address each feedback item. So, it's intending for them to respond in this space

here with what they're going to do about those items in the table, not just these columns, but also to respond below here.

Meeting 21 - In Class Prototype Feedback/Critique

Names:
Description of design being presented:

Solicit feedback for your prototype and testing plans

Positive Feedback	What Still Needs Work?	Suggestion for Improvement

*Add more rows as necessary

Select the top 5 feedback items for your **prototype** AND the top 5 feedback items for your **testing** and respond to them below. Be sure to include a plan to address each feedback item.

Figure 37. Assignment Sample with Unclear Requirements due to Formatting

One stark difference between the on-campus course and the high school class was the number of students in each class. The enrollment for Purdue Tech 120: Design Thinking in Technology courses is typically around forty (40) students, where the high school may have as few as eight (8) students in a class. While the pandemic may have contributed to the limited class sizes, it is a scenario likely to repeat itself, as it was also a pilot program for upper level, dual credit students. Smaller classes offer more time for teachers to engage with students, but also shifts classroom dynamics and group dynamics. One teacher pointed this out as they asked the researcher:

I do have a question about like how you see these groups. So, like with my class, I have [a small number of] kids. So I for the last project, I broke them in the [a few] groups of four. So when they come back [for project three] and you say break them into groups, like do you want them in the same groups or different groups? Or how do you foresee that?

On campus students are encouraged to join a group based on their interest in one of twelve (12) engineering grand challenges. The researcher acknowledges that the intention of the grouping may not be a possibility as they respond:

Determine groups in whatever way makes the most sense to you. I know if you're looking at this, there are so many things that we're trying to do here on campus with students that are in class and out of class and having 40 students per class, that it may not make sense, for a smaller, high school classroom. So, if you want to do teacher choice to group students, or student choice to group them, that is fine.

Other curricular supports offered by the researcher included assignment modifications specific to Covid-19. After one school switched to all remote learning, a teacher reached out asking:

Yesterday, I gave them the assignment of doing the observations, and so today, in theory, is the day for them to do all that prep work. But even if tomorrow we do that prep work, they're doing it from home, so any suggestions for how to do observations from home?

There were concerns on what modifications would be acceptable, and how much evidence of achievement may be needed for each checkpoint. As Purdue had already modified curriculum for students that needed to attend the course remotely, the researcher was able to share modifications that the high schools could apply with their students. As students were focused on Covid-19 procedures at school, these included using some modifications the teachers had utilized in the summer professional development, such as drawing a picture or finding an image from the internet to represent something they experienced. Students were also encouraged to utilize YouTube videos and documentaries to conduct observations, taking screenshots of relevant moments.

Online resources that were utilized in the professional development were also modified and shared with the teachers to help adapt their classrooms to a virtual environment. Venn diagram templates, for example, were recreated as Google Jamboards to share with the students.

One of the larger areas of concern revolved around prototyping for the final project, worth a considerable portion of the student's grade. If students could not meet in person, what

were the expectations for a functional prototype? The Student Success Coach shared what one of his five-person groups did in the spring of 2020:

So, with each person, they did a different kind of prototype. And this is again during Covid, so they weren't next to each other. One person did a 3D model, another person made a sketch or preliminary sketch of what they thought it could look like. There was a student who had access to a 3D printer, so he made one of the ball joint sockets. This student went through and did a quick representation of what it could look like with cardboard, and then another student went through, and they made this out of Lego or K'Nex, but they made a little robotic base that they programmed to drive around. They have some descriptions of the functionality, what it was able to do at this point, and this is still leading up to what they're going to get it to do next.

A teacher asked, "Would you consider that an exemplar?" The researcher responded:

Given the situation, I was really happy with how this turned out. That they were still able, this is four different students and four different states, and they were able to split it up and still come up with something that represented what [a prototype] could look like as a whole.

Absences, and providing adequate make-up work, were also a concern for the teachers. Whether it be from Covid-19, family emergency, or unreliable transportation, high school students find themselves missing multiple days of school. One teacher shared their experience of working with a student that had already missed several consecutive days "They emailed me the other day wanting to know about just missing so much school. That's part of the problem that I mean, they emailed me, and we've had conversations, but I don't know [how to proceed], to be honest." While some assignments had clear modifications, others required the student to solicit feedback from a classmate. The researcher offered a modification that would prevent taking time out of class, while still meeting the intent of the assignment:

If they miss a day in class with a supposed to have a partner, they can [get feedback from] a brother or sister, they can do that with a parent. If you want to [have them provide the feedback instead, they] can look at someone else's project and talk about, 'What did they do for their project? How does it stay together?

How do you think this relates to the criteria?’ So, we can modify it just a little bit so they can still respond without feeling so overwhelmed.

Students were not the only ones who missed class, modifications were also made for teacher absences, as when one teacher had to quarantine after testing positive for Covid-19. In prepping for a group feedback day, one teacher asked if they might combine groups with another class for a different viewpoint of feedback. It was then that the other classroom teacher shared “I am out on Friday, but if you want to take them you can. I have three groups.” After some discussion, arrangements were to combine classes until the other teacher was able to return to their class.

The last form of curricular modification documented by the researcher had to do with student accountability. Though not part of the curriculum, the researcher shared extra assignments that might be created to increase student participation and satisfaction with the course. For one assignment this was simply setting a due date for scheduling an interview, as they went on to describe:

Knowing how the students struggled with interviews and knowing that their interviews is supposed to be 20 to 30 minutes, I would suggest giving them some strategies, and also adding an assignment. If you are okay with it, I will add an assignment for you. That way it's there in Brightspace, and you don't have to worry about messing with it to confirm when they are interviewing different stakeholders. [The assignment documents] that they've made contact with them, and they set up a time to have a 20 to 30-minute conversation.

The researcher found that many on-campus students often waited until an assignment was about to be due to start working on it, a trend that was even more apparent with the high school students. Creating an assignment to schedule an appointment not only pushed students to make those connections early, but to follow through after they had been confirmed.

Another form of student accountability came not from an assignment, but from a resource. The rubrics for the design journal and final presentation are more in-depth and condensed than any others in the curriculum. The researcher had experienced that students who did not read closely, often overlooked important aspects of each rubric, preventing them from the opportunity to earn full points. While the curriculum addresses this by having the instructor meet

with each student group about formatting and presentation planning, the researcher shared an interactive checklist with the teachers to save time and act as a supplement (see Figure 38):

I made a checklist that it's not completely integrated into the curriculum. But it does replace that item and gives I think that the students a lot more structure. So here's the checklist for the design journal. Below is a checklist for their presentation.

DESIGN JOURNAL CHECKLIST		
Item to Check		Notes for Teammates
x	1 You met with your group to look over this checklist	If not done, you can assign tasks to specific group members here
	2 Instructions in RED are removed from the design journal	
	3 Title page is complete with group number and group member names	
	4 Table of contents is created for each entry in the design journal.	
	5 Major headings are aligned with the the Meeting schedule	
	6 Subheadings create a logical flow through the design process	
	7 Headings/subheadings are hyperlinked.	
	8 "Meet the Design Team" is complete with each group member's name, their year at Purdue, their major, their role in the group, and career aspiration(s)	
	9 Executive Summary is completed and all bullet points addressed	
	10 How you reached your final POV statement	
	11 Who your stakeholders are and why	
	12 What your final solution is	
	13 A summary of your prototyping sequence	
	14 Your feedback received and any data collection results	
	15 Design journal is comprised of all Project 3 content	
	16 Prototyping documentation	
	17 Action items from you instructor	
	18 Resolutions to those action items	
	19 Resolutions are easy to find in either their own section or within the document with a key to find them.	
	20 Meetings are sequential (17 before 18, 21 before 22, etc)	
PRESENTATION CHECKLIST		
Title of Slide(s)		Description
1	Credibility of Presenters Established	Identify both the number and quality of people interviewed Identify number and quality of sources cited Identify number and locations of observations
2	Problem framed in the context of one or more global challenges	Identify grand challenge for engineering Your group's interpretation of the grand challenge In depth description of the problem
3	Stakeholders	Highlights the concerns of multiple stakeholders Concerns are based on comprehensive, timely, and consistently credible sources Rationale provided for why stakeholders were selected POV statement provided with user, need, and insight
4	Research	Summarize and list specific articles used to justify problem Summarize and list occupations/relevance of stakeholders and field experts interviewed Research substantiates the existence/relevance/prevalence of the problem
5	Existing Solutions	Pictures from Benchmarking from a wide array of clearly identified and credible sources List both strengths and shortcomings of benchmarked solutions Strengths and weaknesses are supported by relevant data
6	Proposed Solution	Brief description of how your solution addresses weaknesses of benchmarked solutions Decision matrix provided to show your constraints and criteria List multiple functional considerations for your solution
7	Design Viability	Describe how viable your solution is based on functional considerations Design is realistic and its proposed success is supported by credible evidence
8	Functional Prototype	Brief walkthrough of prototyping evolution pictures leading to final solution Functionalities are explained in detail (annotated sketch if applicable) CAD model, detailed hand drawn sketches, or other graphic of intended product (not current prot
9	Testing and Data Collection	List tests used to test various functionalities Justify relevance of tests based on target functionalities Summarize conclusions of data obtained from each test
10	Data Analysis and Implications	Pictures of testing process Graphs, charts, or other visuals Summarize the implications of the successful implementation of your solution - what is the impact
11	Next Steps	What research is still needed? What manufacturing considerations are needed? What support would you need from anyone watching your presentation?

Figure 38. *Supplemental Checklists to Interpret Rubrics*

Teacher's Response to Weekly Meetings

Frequent communication from the university is one feature of the facilitator model. For the piloting of Tech 120: Design Thinking in Technology, the research team chose to make this a weekly occurrence, for up to an hour each week where teachers would have time to share successes and challenges in the classroom, administrative updates, and receive just-in-time support for the upcoming lessons. While teachers expressed some reservations about giving up planning time throughout the week during the professional development, the response even a few weeks into the semester was overwhelmingly positive.

Teachers expressed that these meetings helped to build confidence and provide reassurance that they were sending the correct message to their students, as stated by one teacher “The kind of support I needed was mainly reassurance that was on the right page. And like I said before, you did an amazing exemplar. Perfect. I couldn't ask for anything more.” Another teacher reflected on how stressed they were at the start of the school year, noting that there was so much information to try to piece together. When asked if the meetings felt overwhelming, taking away from some of that planning time they responded:

The weekly meeting, if anything, is kind of the opposite of that feeling. If there was something in an email that I misinterpreted, at least we're gonna get on the same page. I think that will be a stress reducer, rather than, you know. Sometimes with emails, I think I'm missing something and adds to my stress, but I think the virtual meeting, will do the opposite. It will actually help me to go, ‘Okay. Things are going good. I have at least an image for the next week.’ So I don't think I'm overwhelmed in that way.

Another teacher commented on how satisfied they were at the end of the year with the performance of their students. They shared “I couldn't have, I don't think it would have been near as good without you [leading weekly meetings]. After, if I taught this two, three times, okay, I'm ready to stand on my own.” They went on to indicate that taking time off from teaching the course, if they did not teach it in the spring, they may forget key components needed for delivery of lessons and grading assignments.

All of the teachers expressed the value the meetings brought to their lesson planning for the week. Surprisingly, every teacher, at some point in the semester, started teaching off of the weekly agendas. One teacher noted that they would occasionally get stuck trying to interpret the

Implementation Plan, even showing it to students to try to interpret, before finding the confidence to move forward with what they remembered as being the main points from the weekly meeting:

Sometimes to me, it was unclear, and I even had the students read it at times, and they're like, 'Huh?' But screw it, we'll just, 'This is what we're going to do.' You know? And I would base that off of the Wednesday meeting.

Several teachers modified and reused the agendas as a document they shared with students. One teacher shared that on occasion they would remove the administrative updates and shared the rest of the plan with the students:

Once or twice, I even just cut out some of what was in your agendas, and just walked them through items that you had already written on our agenda that you walked us through. I just removed anything that was confidential that they didn't need to know or see.

Another teacher shared that creating presentations had become too time consuming, and the agendas had become their preferred method of teaching the class:

Lately, I've just taken the agenda, you've typed up for our meeting notes, and I've used that to recreate my lesson. So I'll delete out everything that's not tied to it. If there's any personal notes you make for teachers, I'll take those out and make it something that when I teach my class, I can just share the lesson outline on my screen with all the students and then we walk through items line by line.

Another teacher preferred to keep the agenda as set of notes or talking points when working with students, indicating that they could have even used more supports if offered:

I leaned very heavily on your notes. I wish there was more of them. I wish the notes were denser. Not denser, but like, I just wish there was more step-by-step sayings. And I mean, what you what you have is good, I just want more. I teach off of those notes.

Other teachers used the agendas to create presentations to share with the students. Even though the teachers had experienced much of the curriculum over the summer, they indicated that the just-in-time support of the weekly meetings helped bring clarity:

That has helped me more than the summer did. I actually take our notes, and like I said, yesterday, I put it into just a really short presentation so that they know what

to expect in the lesson, and I try to expand upon some of it because some of the directions are a little vague.

Another teacher shared a similar comment about using the agendas to plan their lessons, indicating that it had an advantage as a time saving measure:

When you go through what's coming up, it at least gives me an outline, and makes it much faster and easier to put together lessons. I think, earlier in the year, it could have taken me up to two or three hours to plan a lesson, and now it could be as short as 30 minutes as long as an hour. So that part's really, really, nice.

They went on to share how it also brought them clarity throughout the year of what to focus on, or how to break down and explain difficult topics into parts that students could more easily process:

It helps me to see if I'm on the right page, or if there's something I didn't think was important and I'm realizing, 'Oh, that is important', or 'Oh, I accidentally skipped over that.' Or if there's something I was confused on how to explain or lead, you usually end up explaining, and walking us through it, so then I end up not having any questions about it. So that's been like one tremendously helpful piece for planning lessons.

Administrative updates included which students may be having difficulty accessing the learning management system, reminders on deadlines and checkpoints, students with missing assignments from the checkpoints, trends in misinterpretations of homework assignments. This time was also used to schedule class visits from the Student Success Coach and other representatives from the university. One teacher commented on how they liked starting with this piece each meeting "I also think it's been helpful that we start with some of the administration pieces, like students we still haven't gotten this from, and then moving into the big picture and any details for the students." Another teacher appreciated the fact that felt more involved with aspects of the course that they normally would not have access to:

The pieces that I think were always super, super helpful and relevant were getting the like administrative updates of, 'Hey, these students still haven't turned this into us' and just letting us know what issues there are that you guys can see on your end that we can't on our end.

Other teachers noted how they used this information to communicate with students and keep them more informed of when major deadlines were occurring that otherwise may have been forgotten:

I'm glad that you were just continually giving us, like, the announcements, because we pretty much just copied those in and sent them to students. I think it would have been really hard for us to keep up with all of that without your year-long support.

Teachers commented on how the meetings reminded them of the big picture view of the course. One teacher commented on how it helped them shift their focus from what they had just completed, to what was coming up next, to a reminder of the end goals of the course with an analogy, "I like to be reminded of the forest view of the course and where we are, with giving some time for both the trees that just happened and the ones that are coming up soon."

It should also be noted that teachers were overwhelmed this semester. Due to Covid-19, student attendance was more sporadic than normal, and teachers were constantly modifying their lessons for all of their classes to be in person, online, or some hybrid of the two. Even in a normal school year, adjusting to a new course can be intimidating, and teachers may not have the bandwidth to interpret and deliver lessons effectively. One teacher summarized this in their reflection:

I think it's real easy without a meeting like that, to start living a lesson at a time, which can be a recipe for kind of missing and not preparing the way the way that would be best for the students. So, I kind of just like that little bit of conversation and keeping the view more than more than a couple of lessons.

Attendance at these meetings were encouraged but were never required. Nonetheless, teachers prioritized this time and it was very rare that anyone was absent. One teacher reflected on what these meetings meant for them as a facilitator, and why they made a point to be there:

Those Wednesday meetings, you saw I didn't miss any, you know? It was important to me, because you gave me that preview so I knew where I was going that week, and then you gave me some details that helped me, you know, where and it was perfect.

All meetings were recorded and shared in the case that a teacher may be absent or wish to refer back to them. Teachers appreciated and utilized these recordings throughout the semester.

One teacher commented “I had to miss one or two, because some things popped up, but the recordings, I checked out those the times I missed.” Another teacher shared a similar comment:

The first thing that's been really helpful has been those weekly meetings, even missing this one, I went back and I looked at the video of it, and that just helped to get that that full view of where things are going. It's been nice to view them sort of, as a week at a time, that way, I'm kind of looking at the thing that comes after them.

The structure of these meetings encouraged teachers to reflect on their teaching, both successes and challenges. One teacher expressed how grateful they were that they were able to have a collaborative role as facilitators with the researcher, and not a passive one:

I think you did a good job, and I would hope other facilitators would do a good job, of allowing the space to also be a time to collaborate between the instructors. And not be, it wasn't a here's [the university representative] with their presentation for the week. It was very much a check in, and as you know, it was well labeled in that sense. I think doing that was really helpful. It felt so good. In that sense.

At the end of the course, many expressed the connection they felt to other teachers in both helping others along and sharing frustrations. One teacher reflected “I couldn't have done this without the weekly meetings, you know? Like, this was, this was a huge crutch for me. Just being able to ask questions and have conversations with [other facilitators] about what they're doing.” Another teacher shared a similar comment about the support they felt from their colleagues:

I think, especially, you know, there was both this sort of support with the other teachers, because they're experiencing the same student environment that I was. Sometimes they would anticipate a problem, or their students would stumble upon a problem, like a moment before mine did. And I could see them anticipate that coming out really helpful. Or if we, the same thing happened, we could sort of talk about it.

One of the biggest supports that teachers commented on, was that they felt they had a place to bring their questions from the week, and they could have those questions answered. One teacher shared “It's nice to know where our link is, and it seems pretty clear that if we have questions where we need to go.” Another teacher reflected on how disconnected they had felt in

other courses when they were the only ones teaching the curriculum, and how these meetings increased their sense of comfort that someone else was looking out for them, sharing “I know where to go. I don’t feel like I’m alone on my raft. I feel like I know where to send questions and emails, and someone’s looking out for our students.”

The facilitator model allowed for multiple forms of support throughout the semester, and a strong connection between teachers and the university. Teachers communicated at least once a week throughout the semester with a university representative, and received just-in-time support in curriculum, instruction, and administrative procedures.

4.3.4 On-going Support – Applications of Professional Learning

The professional development from the summer was designed to provide teachers with experiences that may help them throughout the semester. This section focuses on what teachers were able to directly apply throughout the year to their classrooms, how it impacted teacher confidence and preparedness, and missed opportunities of teacher identified needs to include for the next professional development.

Professional Learning Experiences in the Classroom

Teachers found that one of the advantages of the summer professional development, was finding new strategies and tools to use with their students. One example would be including a set of countdown timers built into the presentation slides - one for students to present a topic, and second to collect feedback. The teacher reflected on how it helped their classes:

I do think that like, that tool is very helpful for the high school students, especially as having just a timer to keep them on track. Other times they might get carried away with asking questions, or not being motivated enough to get started right away. So, if we put the pressure of time, then they start to, like, feel a little motivated to get the work done.

Other teachers found that they had only utilized one form of brainstorming, and new methods for brainstorming was helpful in their class. One teacher noted how this helped their students to generate more ideas:

The brainstorming techniques I thought was useful. From our perspective, within the design thinking, we've kind of always like brainstorming the bunch of post-it notes on a wall. It was both fun, and a good way for us, because sometimes our students do kind of get in that brainstorming rut where they come up with two or three ideas, maybe five ideas, and it just stops. So it was that was a nice bag of tricks that stood out to me as something that helped later.

Another teacher focused on brainstorming techniques as well, identifying more with the way in which it was delivered. They commented that when they observed the lesson over the summer, they took notes on different qualifiers that were used with students to help them shift their thinking though the brainstorming process, they shared “I just recall that we used like three specifically, that we heard them say, that weren't in the curriculum.”

For one teacher, it was not a new method or tool, but being reminded of one they had experienced before. They shared that format for the design project they completed before the workshop started was something they were familiar with, but was helpful later when walking students through assignment expectations.

The design sprint, that's always a, that was a good experience to walk through. Again, as a teacher, I'd done something similar before, but it's been a while since I did the design sprint. To sort of re-experience it helps when you're sort of facilitating that with the students.

Lessons that teachers experienced over the summer continued to provide context that helped with facilitating meetings throughout the school year. The researcher would often provide a short reminder of what the lesson was and who taught it to describe and discuss what modifications may be needed for student engagement. As a short sample, throughout the semester the Student Success Coach shared the following with the facilitating teachers at a weekly meeting:

“So, meeting three, this is the one that [teacher’s name] modeled for us over the summer. You're watching that video with the hospital...

“So they've just finished their what how, why observations? This is actually the one that you [teacher’s name] led us on, during the summer.”

“Lesson seven is the one that [teacher’s name] modeled for us, this is the information literacy.”

“We just finished interviews for going to thematic identification. This is the same kind of thing we did over the summer with [teacher’s name]. So you have the Venn diagram”

“Okay, so ideation. This is what [teacher’s name] modeled for us.”

“Lesson thirteen prep, there's that Sealy spoon video. This is the same one where you talked to this team over the summer.”

Other professional learning experiences that were incorporated into the fall semester included the recruitment panel that teacher had met with. The researcher pointed out to the teachers that the university would finish before the high school, “So it looks like if I go over here to our calendar, Purdue is over on December 4, but [your school] still continues for another week and a half after that. Is that correct?” The researcher went on to offer support in filling some of those days with students through end of course surveys, viewing the judging of a design competition that both on-campus and dual credit students would be participating in, and offering to schedule time for so a representative from the recruitment panel to meet with students:

We also had over the summer, that recruitment panel, and they talked about the transition to Purdue. They shared some things [students] could do over the summer, having academic coaches, different associations that support women in technology, minorities in technology, and other resources that are available to help students ease that transition, and they sounded like they wanted to come back to [your school] and do some kind of a presentation. But to my knowledge, they haven't done that yet. So that might also be one of these days, where if you are interested, I can give them the range of dates, and set up something where they can talk to those students, it feels like a nice place in the semester once they finish the course [to say] now, here's the next steps.

Teachers, having already experienced the discussion topics, were able to make a more informed decision regarding the value of having such a guest speaker, and identified aspects of the presentation that should have more or less focus for their students.

Another theme from the summer professional learning experience, however, was finding a connection with the lessons in which they had participated. Multiple teachers shared how they were able to use their personal experiences in talking through the curriculum with students in various lessons throughout the semester. One teacher shared:

It helped that as we walked through it, they would have finished step one, and I could say, ‘All right, so you just finished up one, maybe you've written some things like this.’ ‘When I did the summer with another teacher, these were some of the things I noticed as I talked to my user.’ And I can say ‘Your user is different, but...’ You know? How we can pull out this sort of experience of being in the project, that was helpful.

Another teacher shared a similar experience. They remembered conversations that took place around different scenarios in one part of the curriculum, and had the researcher share documents from the summer to help facilitate discussions with their class:

When we had to watch the video about, you know, empathizing, or trying to figure out what the people in the video were feeling, doing, whatever. Having gone through that experience, I was like, ‘Oh, this!’ You know? And I went back and actually had to go to you, because I couldn't find where we had recorded all that information, and it was within that presentation that I can't remember who gave. But anyway, yeah, that allowed me to actually help the students, because I could actually sit down and ask them questions based on our conversation, you know? As a group. And the contributions that everybody made during that lesson really helped [the students] to understand.

Both the teachers and the researcher were able to utilize many of the experiences from the summer professional development to enrich the experiences of students in the fall.

Preparation for the Fall

As part of the research throughout the semester, teachers were asked to think back and reflect on how the professional development prepared them for teaching in the fall. Some

teachers pointed out the value in knowing who to contact and the roles and responsibilities of various university representatives. Other teachers appreciated the time each morning of the professional development to reflect and ask questions with the KWL charts.

Some experiences were longer lasting, such as calibrating grading expectations. In their final interview, one teacher reflected on the importance they saw in not only checking that their expectations for students were inline, but that other teachers were in agreement, stating “I found the grading piece where we all tried to calibrate how we would grade something and then we talked through our thoughts. I thought that was super valuable.”

Teachers expressed that having time to interact with materials increased their confidence in navigating materials for lesson planning. One teacher reflected back to the time allocated to navigating the LMS and Implementation Plan, sharing “I feel like having an introduction to that over the summer helped us to kind of know how to use the resources and how to plan those lessons.” Another teacher shared a similar comment, noting how struggling with interpreting the curriculum in a structured environment helped them feel more independent throughout the year:

I forget what the document is called, that had all the content in it, but to give us a chance to struggle with it on our own, and try to piece it together and be able to discover, ‘Okay, this is where things aren't making sense. I now have questions I can ask.’ ‘Here's my thought process’, and then trying to articulate that back. And then getting feedback from you guys on like, ‘Hey, here's how to interpret these pieces, and this stuff that was in that list isn't as important to actually have in a presentation or a slide, that's more of your own personal knowledge’, like just learning how to navigate the materials.

One theme that all of the teachers shared, was an appreciation for modeling a lesson. For some teachers, one of the values of this was hearing input from colleagues, and seeing how lessons were approached in different styles:

Getting to hear from colleagues and peers just what they liked about the lessons, and what areas or ideas they have to improve it, or just other ways of doing it. Because no one way is going to meet every student's needs. I think it was good to have that collaboration.

Another teacher shared a similar comment. Focusing on not only how it could be delivered, but how they might adapt it to fit their teaching style:

I'm a big fan of seeing how somebody else would teach it, and then being told, feel free to make it your own. I think, if I haven't seen it, in some sense, I kind of have this back of my mind fear of missing out on really what is supposed to be happening, or focusing on the lesson plan and not the learning. So I'm a big fan of seeing a lesson given but then being specifically told, feel free to make it your own beyond that.

Not all teachers felt the same way in learning from others. One teacher commented that it was their own experience of piecing together a lesson and presenting it as if it were their own students and classroom that was of most value to them:

The individual practice, like I, I think I gained the most just from the one that I taught. Like I didn't, I didn't necessarily learn as much from I mean, I learned from the other people, but I think it was most helpful for me to just go through the process.

One point that was clear from talking to the teachers was the value in engaging with the prep and deliver of a lesson. One commented "The modeling teacher teaching lessons, I think, was definitely helpful." Another teacher indicated that "I think the, like the being able to do a model lesson was probably the most useful because it helped us interact with like the, the course, outline, and kind of understand how it all fit together." Others felt it gave them more confidence throughout the school year when teaching the same lesson:

The day that I had to do the assignment, like, I knew that one. Like, that was what was nice. I had deep knowledge of that, and it was, you know, I don't know if it's because I was assigned it or because I genuinely liked it, but I really resonated with that particular lesson because I knew that lesson, and it made that lesson really easy to teach.

One teacher was quick to point out that it was not the same as a classroom environment. The participants were model students and the environment was virtual, but the experience was effective enough for a skills transfer. The teacher shared:

I think it was very helpful to have each of us teach a lesson. Um, we didn't quite get the feel that you would have with students, but it was nice to have experienced some of the lessons and the way it went. That was definitely useful. I'm not sure

how to push that to be more classroom, like without it, having real students, but it's definitely a useful thing.

When asked if other lessons would have been more helpful or representative of the course structure and materials, one teacher offered “I think that it, they did a good job representing the work that students would do in class.” Another teacher pointed out that seeing more examples of the curriculum, especially from the first half of the course, may have been beneficial, reflecting “Now that I'm looking back, for me, it just would have been more experience working with the material. And that's all. It's been because going through [Project 1 and Project 2], is helping me get them through [Project 3].”

While providing more opportunities for teachers to engage with curriculum is tempting, there is a balance to be found with cognitive load. One teacher shared an experience they had with a different course:

Okay, I'll be honest. When I taught another class, they made us [go through the entire curriculum], and it was so accelerated. I had absolutely no summer that year, and it was, they gave us too much. Then I started the school year and had no break. And now, I wouldn't want to do that.

From clear expectations on grading assignments to preparation to deliver content, teachers reflected on many ways that the summer professional development helped to prepare them for facilitating the course.

Missed Opportunities

It was noted that teachers were asked to think back and reflect on how the professional development prepared them for teaching in the fall in interviews with the researcher. During this time, teachers were also encouraged to reflect on items that would have better prepared them for the fall semester, or changes they would make if the professional development were to be offered again. Suggestions included providing more of a course overview, providing details on assignments that teachers struggled with throughout the year, and procedural suggestions for teacher engagement.

A suggestion offered by more than one teacher, was seeing Purdue instructors teach the course. Throughout the semester, teachers questioned if they were focusing on the right topics and providing comparable feedback to the on-campus instructors. Upon request, the researcher

was able to acquire recordings of several lessons, and provided these to the teachers. One teacher thinking of how recordings may serve as a reference point throughout the semester commented “We eventually got some video of some lessons. It would be it would be nice to maybe have like a full repository at some point of lessons being given.” Another teacher made a similar comment, focusing more on a discussion around lessons than a repository, sharing “I think it would have been nice in the summer to maybe have an opportunity to either observe or through video somehow see how some of the key lessons looked in the college setting.”

Along similar lines, other teachers were looking for more feedback that they were in line with university expectations. One teacher commented “What bothered me was whether I was doing it well enough to be Purdue standards, and I wanted to make sure I was. That was like, super important to me.” Another teacher was more specific, indicating that they stressed throughout the semester if they were providing the same supports as university instructors.

I like the examples of the lessons, and going through them, and creating them, and giving the lessons to the group. I would have liked a little more feedback. Not from the other people that were attending necessarily, not that their information isn’t valuable, but more from [the research team], and you know, those of you that actually teach the course at the college level, because I stressed over ‘Am I meeting the needs of what you expect of your students?’ I want to make sure that I am on that same level presenting, and expecting, and grading, and doing everything that you do.

For some, they left the summer professional development without a clear big picture overview of the course or how the individual lessons fit in. While lessons were mostly sequential, they were not strictly so, causing some confusion. The pre-workshop activity was from the prep work in Lesson 4, and the lesson that was modeled on the first day from the research team was also Lesson 4. Teachers then went on to model Lessons 3, 6, 7, 8, 10 in that order. The teacher shared the effect this experience had on their understanding of the course:

I do things sequentially. I'm looking for milestones, and what do I need to do to meet this, or I need to do to meet that. And so we kind of jumped all around, we didn't, you know, take things step one, step two, step three, and I didn't realize, I didn't have the big picture yet. So, when we were jumping around, it was, you know, I was in a void. I didn't know where things were going, and I don't, I'll be

honest, I don't deal well, with that, you know? I kept trying to just go along with the program. And I always assume I'm going to have clarity at some point.

When asked what that meant for preparing for the semester, the teacher commented:

I did not feel prepared. When I started, I didn't feel prepared. Only because I'm a person that likes to see everything before I step in, and I'd like to know what I'm doing, and it was a little bit, I felt like it was a little bit sporadic to be quite honest. I didn't necessarily see the connections.

Another comment from teachers was that they wished they had engaged more with the prep work for each lesson, and they would have if it were required. Prep work was modified such that six (6) lessons in four (4) days would be manageable in a couple of hours, but when presented still seemed intimidating. When answering a question about the amount of prep work, one researcher responded:

You had posted a question [in the chat] about reading all those pages for tomorrow. Good, good point. So, what we'd like to do is engage you to the extent at which you're comfortable and accessible. So the teacher that's running that meeting three POV tomorrow, we'll be making some assumptions that you have looked at that. Everyone has looked at the material, just like the students would have looked at the material before class, but we fully recognize that you all have other distractions that are occurring, and you are literally just wrapping up grades. So [teacher] and everyone, if you have a moment to skim over those, the preparation for Meeting 3 for tomorrow, that'd be great. If you don't have a moment, then we'll just get by there as well. So just engage in this to the extent that you're able and comfortable, and if you are overwhelmed for a moment, and you can't get through the couple of pages for tomorrow, that's fine too.

The teacher interpreted this statement to mean that all readings and prep work were optional, sharing:

This summer, you gave us the option if we wanted to do the pre-class assignments. We could, but I did not, and I think that if I had, it would have helped me to see a little bit more of what's expected of students before class. So maybe, maybe not all of the guests lessons that you go over in the summer for

teachers, should you require them to do the pre-class work, but maybe just one of them.

At the end of the semester, teachers identified the lessons that posed the greatest challenges to students and offered suggestions for future iterations of the course. Two teachers focused on terminology, and how some reoccurring terms in the course felt unfamiliar. One teacher suggested including lessons with these terms as part of the summer professional learning experience, sharing “Now we’re getting into lessons where we’re talking about like, models, and using vocabulary that might be new to staff and students, and it might be helpful if one of the guests lessons over the summer might include that.” Another teacher focused on how adding a glossary may help to streamline the course, as it may be difficult to know what teacher are and are not familiar with:

A glossary of terms, and maybe the definitions, and perhaps an example beside it, I think could be super helpful. It was just the constraints and criteria, Lesson 15 I think, that had me think of that, because, again, those aren’t terms that we use at our school. Like the ‘criteria’ is one where what we use is ‘design requirements,’ so that one was very easy to understand.

Another resource that teachers identified they could use were a set of presentation slides for the lessons throughout the course. Teachers indicated that they wanted something to help organize the lessons and reduce the prep time, not wanting a lot of details, but rather “More of an outline. And, you know, when somebody gives me a PowerPoint, I turn it into my own. What works for me. But it gives me kind of that boilerplate or outline or something.” Another teacher acknowledged that the researcher shared presentation templates to help teachers transition to being online, pointing out that this could be beneficial throughout the semester:

I’ve been meaning to try to get into the habit of sort of creating some kind of a slide deck, not because I want it to be overly prescriptive and luxury, but something to sort of pace me through the things I want to discuss. So, if there was some common document in that way that might, you know, still kind of not feel too lecture prescriptive. I know you shared that one thing at one point, but having a set of those might be beneficial.

Some suggestions for improvement in the professional development were more specific to individual lessons. One teacher indicated that decision matrices were a new concept for them:

I had seen decision matrices before, but I don't know that I've necessarily taught a complex model of it before. Normally, it was like three rows, three columns with Yes/ No. So I think like I didn't have too much of a hard time with that, but I think that one like that would be great to have had modeled for me.

Another teacher felt that they could have used more guidance deciphering the grand challenges for engineering. These challenges are what students use as inspiration for their final project, and teachers felt they would be more confident with more examples of how to introduce them to their students. One teacher shared:

I feel like the one piece that I wish we would have hit this summer was like, the actual grand challenges and going through all of those. Maybe I just forgot if we did do those, but in explaining the last project, and like setting up the grand challenges, and like getting them to pick topics. That was something that we didn't cover from what I remember this summer.

Other suggestions focused on the delivery of the professional development and the level of teacher engagement. One teacher felt the prototyping and design journal could have been a bigger component, suggesting:

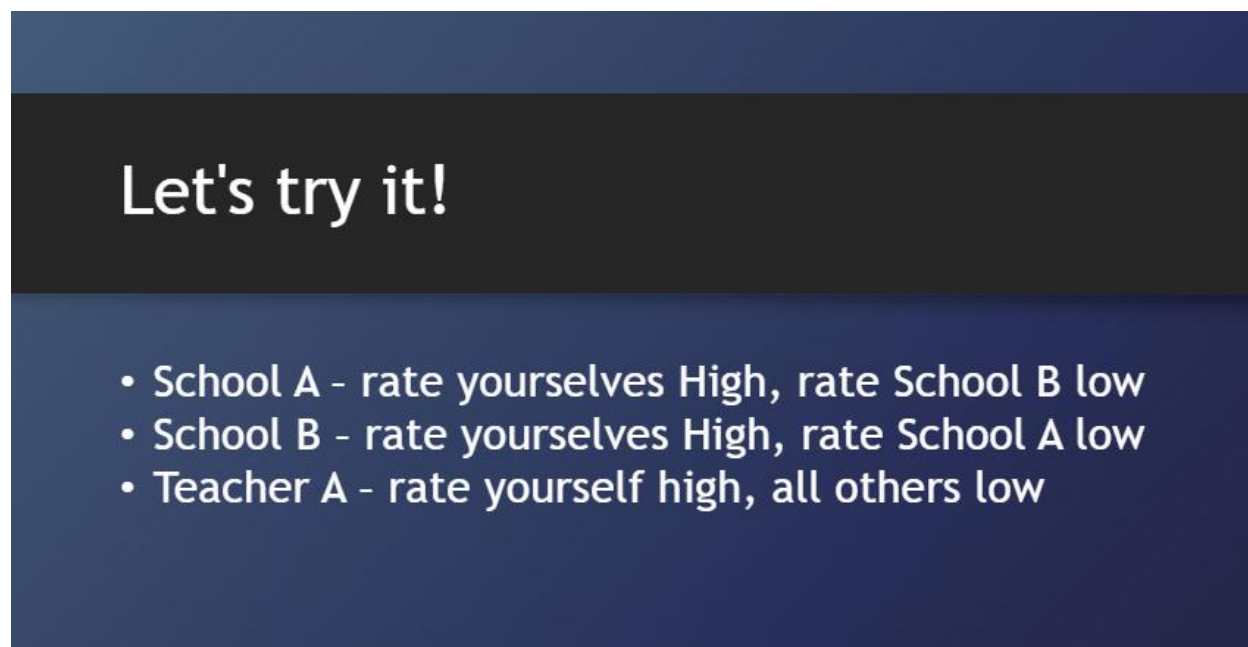
It's got to be very intensive. And, and, and try to work through as much of everything as you possibly can. You know? Have that be part of it. Have them work on part of the design journal. Have them do a prototype. Have them be a part of the competition, and you, you still only have one week to do this, but just say, 'Okay, in one day, you're going to come up with a prototype.' You know? So that everybody can see the process from beginning to end, and in kind of a bigger picture way.

Other teachers felt that too much detail was provided on certain parts of the curriculum, such as the peer evaluation software that students would use throughout their final project. The research team provided a brief overview of what the software was, and then asked the teachers to engage with it to provide false evaluations of their peers (see Figure 39) for about thirty minutes (30). One teacher reflected "The CATMEs that we do, and then the explanation of that, I do think, uh, what was a little bit confusing." When asked to explain, they offered:

I think that maybe having some of that training as we went might have been a little less overwhelming at the beginning. Like, maybe in the summer training,

just saying, Hey, we use this tool CATME for students to rank themselves and their grade is dispersed, you know, based on that multiplier of how they're rated. Like, I think that probably would have been enough for the summer.

The teacher indicated that the support they received during the school year was sufficient for leading their class, but the experience over the summer was too short for a full understanding, and long enough that they were confused about what it was or why they were using it.



Let's try it!

- School A - rate yourselves High, rate School B low
- School B - rate yourselves High, rate School A low
- Teacher A - rate yourself high, all others low

Figure 39. *False Evaluations for Peers using CATME*

A couple of teachers found that they thought they knew what how to interpret rubrics from their summer professional learning experience, but the last two rubrics were more complicated than they had anticipated. While time was dedicated to having teachers read and have the chance to respond to these more complicated rubrics during the professional development, it was noted that their interpretations were not directly challenged. One teacher suggested reading rubric items out loud to provide the opportunity to ask questions about them:

I'm just thinking on their pitches and their design journals. I think there were some pieces there towards the end, that may need walking through. Specifically, the design journal submission. Like, walking through that rubric, having the, teachers read out each piece, and then giving them a chance to ask questions. If

they don't have any, then move on. Or, you could just highlight what each piece means.

It should be noted that these suggestions for modifications to the professional development were compiled from both mid-semester interviews and final interviews with the teachers. This was after they had experienced the curriculum and could identify where supports prior to the start of the course may have been beneficial. All suggestions were documented and shared with the research team.

4.4 Positive Reception of the Facilitator Model

Throughout the semester, teachers reflected in interviews with the researcher on the both the course, Tech 120: Design Thinking in Technology, and the facilitator model approach utilized to allow students to earn dual credit. While this research does not focus on the effectiveness of the course curriculum, components of the curriculum contributed to the preparation and supports of teachers and as such are included here. Reflections on their reception were capture in three main categories, the structure of the course, student reception, and teacher reception.

Course Structure

Throughout the semester, teachers shared how much they enjoyed the structure and organization of the course. One teacher reflected on student reception regarding the transparency of assignments expectations when compared to other high school courses:

They just liked how Brightspace was structured so they always knew what the pre-class assignments were and the in-class assignments, whereas for us, at the high school level, we don't have every assignment mapped up for the entire semester right away. It might be that students find out the week before, or a couple of days before what we'll be doing the next day in class. So, I think that's been very helpful for our students.

In addition to assignments, many teachers shared in weekly meetings and individual interviews that discussions about the assignments were invaluable. The course curriculum encourages students to process and synthesize readings, resulting in student led discussions about

the course content. One teacher shared “I love the discussions.” When prompted, the teacher continued, “I think I think everyone is learning. I love that this model, you know, we have these discussions over [so many things]. I go back to the Vietnam malnutrition, looking at what's there.” This particular example identified family outliers who were not malnourished to incorporate design thinking as a procedure instead of a product to aid other families in the area. The teacher continued, “Just because you're coming up with a solution doesn't mean that you have to do something different, maybe there is something out there that's working use it, you know, don't throw the baby out with the bathwater.”

Teachers found that when compared to other similar design courses offered through the high school, the Tech 120: Design Thinking in Technology curriculum allowed students to engage with their projects for longer periods of time, allowing for a depth of skill development. This added time led some students to describing the course as *easier*, even though the expectations were higher. One teacher shared:

One of our students took our [design] course last year. He said that he likes Tech 120 better because he said it feels easier, but like not that the work is easier. He said the work is a little bit harder, but the class is easier to follow because of the way that you guys have it structured, and that you get more time to work on projects.

In addition to more time to work on projects, the course is designed to iterate on key skills. Students have a short amount of time to work on Project 1, then apply those same skills to Project 2 where they are using the same skills and structure with higher expectations. Project 3 is even longer than Project 2, and again, utilizes the same skill set while increasing expectations. A teacher summarized this process:

I think that what Tech 120 does, is it does a better job of setting our students up for success of, ‘Hey, you do a really short project at the beginning, then a slightly longer one, and then you get several weeks on your big final project and enough time to prototype and really dive deep into all of this.’

Teachers continued to make comparisons of the course curriculum with similar design classes throughout the semester. The researcher documented these comparisons and shared them with the research team.

Student Reception

Teachers had much to share about the student reception to the Tech 120: Design Thinking in Technology curriculum. Just as one teacher had identified the advantages of an iterative curriculum, another teacher shared a similar comment from a student:

He was just saying that he really likes that because the project is spread out, like the class is spread out over an entire semester rather than it like changing every six weeks, it forces him to dig deeper into concepts he was already familiar with, and he really liked the challenge of thinking deeper and harder.

This idea of digging deeper into concepts students were already familiar with was one that multiple teachers voiced. One shared “I think they definitely felt some connection to what we've done at the school in the past with design thinking, but I do think that they saw the differences, and they felt that it was a level up.”

As previously documented, the course structure, introduction of a Student Success Coach from the university, how students interacted with materials, and the depth and rigor of assignments were not typical experiences in other courses students were familiar with. According to teachers, students associated the course with Purdue University, and many indicated an increased interest in matriculating after high school. One teacher shared an observation, “Without having directly asked them, I think that some of them are more interested in attending Purdue, or a college in general, after Tech 120. Most students said they really loved the course.” Another teacher indicated that not only did students seem more interested in attending Purdue, they enjoyed the challenge “I think students are more interested. I think a lot of them said how the design thinking process really ‘clicked’ for them, and I think they really enjoyed the challenge of being in a college class.” A third teacher shared similar comments, noting that in spite of the complications of participating the course during Covid-19, students gained confidence that they would be successful at the college level:

My particular group loved the class, hands down. They enjoyed it. You know, we had we had some mishaps, of course, with the Covid and everything. But yeah, I would say they are more interested in coming [to Purdue] and have a little bit more confidence that they can handle themselves in a college class.

In addition to students feeling an increased sense of confidence, they were also motivated to succeed. One teacher shared how excited their students were that they had the opportunity to even participate in a dual credit course:

They're excited about it, and they want to put their best foot forward. Um, it might be for one or two students that there might be a little bit of anxiety, but I haven't seen like, I know what the anxiety looks like for students and other courses, and I don't think it's the same thing that I'm seeing for Tech 120 students. They are concerned about, you know, wanting to do it quote, unquote 'Right.' I think it is definitely more of just excitement that they even have the opportunity to take a dual credit course.

This was an observation shared by other teachers as well. Another teacher shared the enthusiasm students had when approaching the course, "I think the student buy-in has been 100%. I think just framing it as 'you're getting college credit' is enough for most of them." A third teacher talked about how student motivation made for an exciting class to teach, sharing that they have "[just under 15] kids that are really highly motivated, and really want to be there, which is just always fun to teach a group like that."

In order to enroll for dual credit, students had to apply to the university. Since the decision to accept or deny these applications happened after course loading, several students ended up in the course for high school credit only. While this could have been disappointing, teachers shared that these students were just as motivated as their dual credit peers:

All the students that are taking the course without credit, they wanted to take it for credit, and it was either Purdue didn't approve their application, or something didn't get submitted on time. So, they were disappointed about that, but rather than just not taking the class, they were so interested in the class anyway, that they're like, 'I'm still going to take it.' And so, it's not changed the dynamic of our class at all. They are equally passionate, equally engaged, and they treat it just as serious as our for-credit students.

Teachers continued to comment on the level of student engagement throughout the semester. At a mid-semester interview, one teacher shared that the students level of interest and engagement had increased since the start of the semester "I think it's been positive, just they've been a lot more engaged in their course content and taking it really seriously." Another teacher

shared a similar comment in a meeting in early October, noting “We've seen some increase in engagement for some students, and they seemed they seem to be really excited.” Going on to say “I just think overall, students ask questions in the class when they have them, and they're just really excited and eager about the class.” A third teacher noted that students were forming their own groups to work outside of class when Covid-19 complications made interactions difficult:

I've got a great group. I could not even be there, and they would get most of it done, you know? Everybody shows up, if they don't, they're calling each other. They set up their own meetings, they have everything. I stay on in a main chat, and they keep coming back to me asking questions, and then they go back to their own Hangouts. It's just been a good experience all around.

Throughout the semester, teachers also noticed an increase in the confidence of their students. One teacher shared an ‘ah-ha moment’ they noticed with their class when they realized that the work they were putting into assignments would be acceptable at a major university:

In some of the early phases, I think they went 'Oh, this is this college? Okay. Okay.' I think they're trying to run into some of the growth pains that really any college student would run into. But they, they were ready. They're ready for that as much as you know, your average college student would have been.

Another teacher noted how proud some students felt after receiving a perfect score from a college instructor, sharing “They were very, very confident. A couple of them, like hands down, they thought they were perfect.” Other teachers found that this confidence translated into growth with working in a team and taking on leadership roles:

I think we have several students who were already confident, and they now feel more confident in approaching college. Some of them ended up being natural leaders for their team, and actually showed a lot of growth in their leadership abilities of like, you got to include your team members. You can't exclude them from conversations or discussions or decision making.

Teachers identified that along with motivation and confidence, there was a sense of belonging and pride shared by students. One teacher recounted the anticipation felt by upperclassmen, and their role as a teacher in encouraging them:

I think that there probably was a feeling of belonging of, ‘Hey, we're doing this dual credit course, isn't that kind of cool?’ Like, we're seeing that the

upperclassmen may kind of picture their foot going out the door and into the next space. I think there is sort of, there was a little bit of pride there. I think it can be something that is ramped up, and we can foster that more, but I do think it's there.

In addition to being proud of earning the course credits, teachers shared how proud students were of the assignments they were completing. One teacher related this to the enjoyments the students found in the course, sharing “I think they are proud of, for the most part, of what they're doing. And they do like the class.”

At the end of the semester, students were left in anticipation. They completed all of their course work, and submitted their final project, and now there was nothing to do but wait to see how they did. In a final interview, one teacher shared:

I think a lot of them after [they submitted the last checkpoint], they were sort of proud of what they did, and they seemed to really, you know, realize their capability. I think that they might still feel right now unsure themselves. I think that many of those students when the course is done, and if they've earned credit, they will feel very capable at that point. But I think there's still a little bit of, ‘*Did we do it?*’

Teacher Reception

Perhaps the most important group for the success of a dual credit course is the teachers, the facilitators who interact with students daily in the classroom. Teachers were quick to find similarities with courses they were familiar with, but also recognized that there was added value with the dual credit course content:

I really like it. It is similar to our [other course] which is kind of expected, but the things I've come to appreciate are some very intentional strategies around the different sort of phases of the design process. Sort of just the way of talking about it. Like, we've always talked about observations, and interviews, and research, but I think that the course kind of took it up a level by talking about triangulation and talking about why we're using these multiple sources.

Throughout the semester, all of the teachers indicated that they enjoyed the course. One shared, “It's fun! It's been fun to teach.” Another offered “This class is really fun, I'm loving it!”

A third teacher recounted how they were so excited about the course, they were telling other teachers about it:

For me, this class was like, you know, I'm going around going, 'Oh, yes, look what I learned! And they did this and benchmarking! And this!' You know? And so I'm not a salesperson, but you'll hear me talking about this class *a lot* because I liked it so much.

By engaging in a facilitator model, and having frequent communication with the university, teachers indicated that they felt supported. One teacher tied their confidence directly to these interactions with the researcher, sharing "I feel like I'm doing okay because I have you, you know, to answers my question so often." Multiple teachers noted the ease of communication and knowing where to go to ask questions. Another teacher shared a similar comment:

If it weren't for you, I wouldn't feel the way I feel. I'm feeling, I feel confident because I feel like I have you in my corner. I can tap you, or message you, and then you get back very quickly, and I can get right back with my students.

Teachers gained confidence throughout the semester. Another teacher shared that they found they were learning new strategies and material along with the students, "My group was awesome. I, I love the class. Everybody learned. I learned. They learned. It was good." Another teacher had similar comments "I like it. This is my favorite class. I feel like I'm learning along with them, and I don't see any problems. I, like I said, I just like it. A lot." One teacher found themselves sharing strategies with teachers of similar design courses:

So actually, I've been going around talking to teachers, showing 'This is what it is,' you know? So research, hands down. Looking, and really being very specific about the observation, and the benchmarking and bringing that into it. The actual solution part to me is the least important as far as the learning part of it.

Teachers indicated that part of their excitement for the course was seeing their students succeed. One teacher shared "They're just grateful and want to meet the expectations of those in charge [at Purdue]. So it's kind of cool to see their eagerness." Another teacher talked about the excitement they felt with seeing students push themselves to put more into assignments, sharing "it was just a really cool to see their more full potential of what they can do, and I think they saw that as well." Another teacher expressed a tremendous amount of pride and emotion when reflecting on how far their students had come:

Just getting to see that the things that we're doing are on pace to what they need to do to be successful, and in this type of a class, I mean, that's, it's pretty awesome. Knowing that I don't have to teach them how to present, I don't have to teach them how to do Google Slides, I don't have to teach them how to work in teams, because they've been doing that since they were freshmen. You know? Knowing that, like, what we've been doing has been right the entire time. It's nice. It's, you know, it kind of makes you a little proud to see that. That you feel like your kids are going to be okay.

4.5 Summary

This chapter included the purpose of the study, research questions, and findings of the study throughout the professional development and on-going support. These findings were organized into four main themes: 1.) Aligning with Purdue, 2.) Identifying Barriers, 3.) Supports, and 4.) Professional Learning. A fifth theme, Positive Reception of the Facilitator Model, was added to summarize teacher-identified successes after completing the course. The aforementioned themes represent the teachers' experiences and needs in facilitating a dual credit course. All data, including individual interviews, focus group interviews, observations, emails, and other artifacts, were collected digitally throughout the research project.

CHAPTER 5. DISCUSSION

This case study examined the lived experiences of five (5) teachers as facilitators administering dual credit for Purdue's Tech 120: Design Thinking in Technology course. It utilized thick rich description of over ninety (90) hours of qualitative data, including individual interviews, focus group interviews, emails, and other artifacts. These data collection methods were selected to lend credibility to the data through a triangulation of methods (Creswell, 1998; Merriam & Tisdell, 2015). This chapter provides a summary of the findings and recommendations for this qualitative investigation.

The purpose of this study was to identify supports needed for professional development, successful implementation, ongoing support, and scale-up measures of a facilitator model using the Purdue collaborative research program.

As there were parallels between the professional development and ongoing support, discussion will combine the time of year data were collected, while addressing each of the four major themes individually: Aligning with Purdue, Identifying Barriers, Supports, and Professional Development. Finally, this chapter will conclude with a presentation of implications for practice and recommendations for future research.

5.1 Conclusion

This case study utilized a qualitative descriptive approach with the researcher in the role of participant observer to explore the following research questions:

1. How and in what ways did this one week-long professional development prepare teachers to teach a facilitator model dual credit course?
2. How and in what ways does ongoing support throughout the academic year meet teacher needs in a design-based, facilitator model dual credit course?

Data collection techniques included individual interviews, focus group interviews, observations, literature review, and documentation of artifacts such as emails and teacher

generated work to develop rich, thick descriptions of the experiences of five (5) teachers as they piloted a facilitator model, design-based, dual credit course. Twenty-one (21) hours of interviews, and seventy (70) hours of observations were conducted with participants and the researcher. The data were analyzed using axial coding and code-recode techniques to ascertain emerging themes that may impact the needs of teachers when utilizing a facilitator model to implement a dual-credit course.

As evidenced in participants' stories and observations, the week-long professional development prepared teachers to teach a dual credit course by providing a hands-on experience, a guided course overview, and expectations for the school year. Hands-on experiences included teaching lessons, navigating programs, reading preparatory work, and completing sample assignments from the curriculum. The guided course overview provided teachers with exemplars and end goals, student learning outcomes, and the sequence of lessons for facilitating the course. Expectations were shared with teachers regarding on-going supports throughout the semester and roles and responsibilities for the teachers facilitating the course, the Student Success Coach, and the instructor of record.

Also shown through participant's stories and observations were how on-going supports throughout the academic year met teacher needs when implementing a design-based, facilitator model dual credit course through just-in-time supports, transparency in grading, and communication with the university. Supports included navigation of software programs and the learning management system, lesson modifications, and identifying students that needed extra supports and scaffolding of assignments to meet learning outcomes. Teachers were provided grading supports through checkpoints in which assignment student work would be assessed by the instructor of record and de-identified trends and feedback could be shared with the facilitating teachers. Supports with communication throughout the school year included the weekly meetings for just-in-time support, and communication with students to provide a stronger connection to the university.

The Student Success Coach was an invaluable component of the facilitator model design, as they fostered a true partnership with the university and provided individualized support for teachers navigating a new curriculum. It is critical that the person serving in the role of the Student Success Coach is actively involved in professional development to not only provide

assignment context when meeting with teachers throughout the semester, but to build relationships and rapport with facilitating teachers. Student Success Coach served an integral role in on-going supports throughout the school year as well, as they met with teachers weekly to provide focus on central themes to upcoming lessons, as well as feedback, supports, and lesson modifications as needed.

5.2 Recommendations and Implications for Practice

The following sections will provide discussion and recommendations on the four major themes that emerged throughout this study. As these same themes were observed in the professional development and the on-going support, these time periods will be combined in each section.

5.2.1 Aligning with Purdue

In aligning with Purdue, common themes included accessing and navigating the LMS and other content specific programs, personalization of the curriculum, communication about participants, withdrawing students from the course, knowing where to direct questions, and curriculum clarity. The following is a brief explanation of each theme, followed by a recommendation for the next iteration.

In this study, teachers were provided time during the professional development to navigate the learning management system and other content specific software programs they would be using throughout the school year. As the semester continued, and teachers became more comfortable with basic navigation, the researcher introduced more advanced and in-depth features. It was observed that teachers had many more questions throughout the professional development than they did throughout the semester. It would therefore be recommended to continue to provide adequate time during the structured time of the professional development for navigation of these programs.

Teachers had many questions during the professional development about the delivery of the course, and how strictly they would need to adhere to a ‘script.’ After being directed to the course objectives and underscoring that scaffolding should promote high student performance on assignments, we saw that many of the teachers were empowered to create supplemental materials

throughout the semester. While speculative, had teachers not voiced this question, the research team may not have explicitly stated the degree to which the curriculum could be personalized to individual teaching styles or tailored to the needs of the classroom. It is therefore a recommendation that expectations are not to be assumed and should be made clear early into the professional development and restated throughout the professional learning experience. It is also recommended that as teachers develop these student supports that they are encouraged to share resources and foster a collaborative work environment.

Withdrawing students from the course at specified checkpoints was a strategy the research team used to ensure participation in this dual enrollment course was a low risk, high reward opportunity for students. The reasoning and the intent for withdrawing students was reiterated multiple times throughout the professional development, a couple weeks before the semester started, and throughout the fall semester. By utilizing not just one checkpoint, but three, researchers were able to support all students proactively and successfully in protecting their college GPA. It is a recommendation that checkpoints remain a feature of facilitator model dual credit courses, especially if the goal is to encourage participation from students who may not be prepared for the workload or are still considering post-secondary education. It is also a recommendation that the instructor of record is in close communication with the university's registrar, and they are clear on the process, requirements, and time needed to withdraw a student from a course.

This study utilized a simplified model in which teachers could direct any questions throughout the semester to the instructor of record. These included questions that required the use of a third party to address such as student account problems, access to various software, academic integrity, and adding or dropping students. This one point of contact for all needs created a sense of community support and is recommended for future course offerings. If it is not possible to have a single point of contact, it is highly recommended to provide a clear list of supports early and often through the dual credit course.

There were a number of times during both the professional development and semester that teachers had questions on specific wording and intent of various assignments. It was found that several assignments had language specific to college campuses that acted as a distraction, and some terminology used was unfamiliar to the teacher facilitator. It is a recommendation to

review and revise the language of course curriculum to better align with a high school setting, and provide a glossary of terms in the course shell to better facilitate instruction.

5.2.2 Barriers

Barriers to implementing the curriculum include common themes of: expectations, interpreting lessons in the Implementation Plan, communicating with administration, assignment completion, scaffolding for interviews, funding for prototyping, navigating between two learning management systems, collaboration time, student supports after matriculation, addressing concerns of curriculum feeling too familiar, online distractions, timing of professional development, class sizes, teacher confidence, and student home-life. The following is a brief explanation of each theme, followed by a recommendation for the next iteration.

Studies on the facilitator model for math curriculum have shown the success of such a model, utilizing multiple choice tests to automatically grade assignments and provide feedback to students (L. J. Pyzdrowski et al., 2006, 2011, 2016). Maintaining expectations for a course with messy problem spaces and open-ended solutions, such as Tech 120: Design Thinking in Technology, poses new challenges to this model. Teachers and students were able to find a high level of success in interpreting these expectations, as each assignment had clear and detailed rubrics to identify and specify what students would need to document to show proficiency for a given task. Rather than being automatically graded by a software program that would evaluate multiple choice or numeric entries, the instructor of record evaluated each student's assignment with the same rubrics the facilitating teachers used to provide feedback. It is recommended that any future course with open ended solutions to assignments utilize detailed rubrics to communicate expectations to teachers and students.

The main supporting material for the course is the Implementation Plan, a 221-page Google document that is used by instructors on campus. This is a 'living document' that contains not only lesson plans, but many other pieces of information, including weekly meeting notes, email templates, and procedures for undergraduate teaching assistants that only pertained to administering the course on-campus. Unfortunately, this acted as a distractor for efficiently locating necessary information. Future offerings of the course may benefit from creating a separate document for facilitating the course with only necessary information included.

In this study the research team helped facilitate communication with administration about a common planning time for teachers to meet with the Student Success Coach. As the facilitator model is more involved than other dual credit programs, allowing for the university to have regular contact with teacher facilitators, it is important that the administration of participating schools understand the implications and value of participating in such a way before making decisions.

Timely completion of assignments was a theme that teachers identified as a possible barrier during professional development, and later confirmed that it was barrier for several students throughout the course. These students ended up turning assignments in late to the teacher facilitating the course, or failed to turn assignments in entirely, opting to submit to the checkpoint before being reviewed. While students may miss in-class deadlines, assignment completion was often not the underlying issue as they prioritized deadlines set by the university. It is therefore the recommendation to create more frequent university submission deadlines. As one of the benefits of the facilitator model is that students can receive feedback from the teacher facilitators, these dates should still be delayed from the in-class due dates for the benefit of students with timely completion of assignments, providing time to receive and apply feedback from facilitating teachers before submitting work for dual credit. It would still be recommended to keep checkpoints aligned with the university schedule, but these checkpoints would be used for the Student Success Coach to communicate progress of students with the facilitating teachers, not for students to submit a collection of assignments. This would allow for more accurate communication of student progress and trends in grading.

Another potential barrier identified by teachers that was later confirmed, was the completion of curriculum specific assignments such as interviews. While the pandemic played some role in the challenges of scheduling and conducting an interview, teachers noted that students struggled with this skill in previous years as well. It is therefore recommended that scaffolding, teaching strategies, and resources be provided to teachers, especially for assignments with a more variable rate of success. For example, students may practice interviewing and critiquing interviews of other students, making practice calls to set up interviews, or even conducting a full phone or digital interview with the support of teachers and teammates all during class time.

One predicted barrier that did not end up posing a problem in this study was the funding for prototyping. As open-ended design projects could result in prototypes ranging from website pages to microcontrollers, sensors, and motors, there was concern that the students would not have the funding necessary to prototype as needed. This study found that students instead created their prototypes within the confines of the resources available. While it would be recommended that schools provide funding to start a stockpile of resources that students may utilize when working on projects to enrich their experience, this also shows that successful completion of the course is not tied to provided supplies.

Providing teachers with their own learning management system, separate from the instructor of record's, had advantages in providing feedback to students, but also caused many setbacks. Teachers switched back and forth, navigating both their school and university LMS, and transferring grades from one to the other. Dual credit students monitored two login accounts, two separate passwords, and submitted assignments in two different places. In addition, as students must be added to the LMS by the university, registration complications resulted in some students not having access to the curriculum for several days of class. For easier facilitation of the curriculum, it is recommended that the high school LMS be replaced by a website, utilizing the university LMS for submitting assignments.

The schools that participated in our study had multiple teacher participants at each location, and often commented on how they benefited from learning from each other's classrooms. As this program is expanded to other school districts, having multiple teachers for a pilot course is less likely. It is recommended that a digital space be created where teachers can interact with those from other schools and districts to create a collaborative workspace.

This study was proactive in identifying supports for students matriculating to the university and sharing that with both teachers and students. As high schools typically end their semester after that of universities, it is recommended that recruitment and support talks be scheduled with schools after the completion of the college course. Teachers shared that this was both useful for students, and appropriate timing as it identified next steps for students and allowed them to ask more informed questions.

In this study, both schools had engineering or design courses that contained similar content to that of the dual credit class. Teachers identified that students may not put in the same amount of effort at these points, as they already felt competent with the development of a

particular skill. It is recommended to hold discussions to promote a growth mindset with students, identifying what parts of the coursework feels similar, what is different, and what can they do to challenge themselves to better develop that skill.

Covid-19 provided a number of distractions, and while future years may not be as problematic, providing opportunities for students and teachers to participate remotely is becoming more widely accepted. It is recommended to continue to develop strategies for online facilitation of professional learning experiences and coursework, and plan for extra time if hosting an event or class online.

In this study, the professional development was scheduled the day after final grades were due for participating teachers, adding an unintended distraction. While dates were planned and finalized with the district in advance of the professional development, the research team was unaware of the scheduling conflict until after the workshop had started. When finalizing dates for professional development, it is recommended to also inquire into teacher roles and responsibilities around the intended time frame.

While Tech 120 class sizes on Purdue University campus may have thirty (30) to forty (40) students in a single section, high school classrooms are likely to be much smaller, changing the classroom dynamics. This disparity was most apparent with student group work. With class sizes as low as eight (8), and groups of three (3) to five (5), students were forced to compromise on their topic for the final project to meet group size requirements. It is recommended that groupwork activities provide alternate grouping guidelines for smaller class sizes. This may include explicit instructions in assignments that groups may be composed of smaller numbers of students, in addition to strategies to aid students in choosing a group topic, either through a ranking system, or by combining topics of interest.

Multiple teachers expressed uncertainty in meeting teaching and grading expectations toward the beginning of the semester. It was pointed out multiple times that while they had hands-on experience teaching a lesson from the curriculum, they had not seen it taught by university instructors to on-campus students. It is recommended for future professional developments, when possible, to include an on-campus component where teachers can observe a summer session of the course. It would be further recommended to cultivate a collection of five (5) to fifteen (15) minute videos of on-campus instruction for each lesson of the curriculum for teachers to refer to throughout the semester. Lastly, early and frequent communication between

the instructor of record and facilitating teachers is encouraged to evaluate student feedback and provide support.

One barrier that may not be possible to address, but should be considered, is that it is not possible for on-campus and high school students to have the same experience. On-campus students can easily meet outside of class to work on a project, have a variety of options with study space, and have limited responsibilities outside of their coursework. While curriculum may be adapted to better support high school students, there are homelife distractions that cannot be accounted for. It is therefore recommended that facilitating teachers utilize time in class for preparatory work as much as is feasible, to allow for smaller group sizes for easier communications, and to provide access to prototyping facilities for the final project, potentially for after school hours.

5.2.3 Supports

This study identified several supports in implementing the curriculum with a facilitator model. Common themes of these supports include student exemplars, grades and feedback, communicating with students, weekly update meetings, and guest speakers. The following paragraphs include a brief explanation of each theme, followed by a recommendation for the next iteration.

One item that all teachers expressed an appreciation for was the exemplars provided throughout the professional learning experience and semester. Seeing not only rubrics, but videos and documents of high-quality coursework helped to orient teachers and allow them to make appropriate decisions for scaffolding of the curriculum. Teachers were pleased to find that many videos from professional development panels were incorporated into the course shell, and several assignments had exemplars provided. It is recommended that the facilitation guide provide an exemplar to all assignments, especially those occurring early in the course.

Due to FERPA restrictions, providing information on college grades may not be possible, what is possible is having discussions around high school submissions and de-identified comments to students. These steps can help to calibrate teachers early in the semester and build their confidence to provide accurate feedback and supports for students as they continue through the course.

The Student Success Coach in this study was very engaged with students. Before the course started, throughout the semester, and after the final checkpoint, students received personalized emails from this university representative. It is recommended that the individual fulfilling the role of Student Success Coach develop personalized mail merge messages to interact with all students at key points in the semester. It is the researcher's experience that many students responded positively to these emails. Several students responded to these emails, asking questions, or providing feedback throughout the semester. It also provided opportunities to meet with students that were being withdrawn from the dual credit side of the course, to make sure they had gone through the proper channels and continue to provide supports to best help them. This small piece of interaction seemed to have a large impact.

In this study we utilized the facilitator model to provide just-in-time supports to teachers over the course of the school year through weekly meetings. Attendance at these meetings were very high as teachers expressed that they prioritized this time and it was invaluable to their teaching experience. It is recommended that these meetings be continued and conducted in such a way that allows for dialogue between the high school and university, includes administrative updates and announcements, and provides a preview of upcoming lessons.

Guest speakers were incorporated throughout the curriculum for students to interact with university personnel including the Student Success Coach, other Tech 120 Design Thinking in Technology instructors, and a representative from the recruitment committee. It is uncertain to what degree this is sustainable, but there is value in continuing to provide students access and communication with university representatives. One recommendation may be to include on-campus Tech 120 alumni or students that matriculated from a Tech 120 dual credit program to provide some form of communication or contact each semester.

5.2.4 Professional Development

A key feature to preparing teachers to facilitate a dual credit course is the guidance and supports they receive during the summer professional learning experience. This section provides a retrospective evaluation of the professional development, and how teachers applied concepts introduced over the summer into their courses. Themes include: focus points of the curriculum, misconceptions, scaffolding, student and faculty panels, navigating course content, calibrating grading expectations, hands-on experience, prep-work for the professional development, a

checklist of requirements, teaching strategies, and a course overview. The following paragraphs contain a brief explanation of each theme, followed by a recommendation for the next iteration.

With a professional development focused on preparing teachers to facilitate a dual credit curriculum, it is important that the goals and objectives are clearly communicated. Throughout the professional learning experience for this study, focal points of the curriculum were made explicit and reiterated throughout the workshop. It is recommended that this is continued such that the intent of the lesson, project, or curriculum is clear.

Similarly, a number of misconceptions were addressed throughout the professional learning experience. This included the use of video, application software, website developing tools and other digital media to create non-physical prototypes. Other misconceptions included the use of low-stakes quizzes to generate discussion, and not as a summative assessment. When presenting an overview of a course, it is important to provide time for participants to summarize and ask questions about delivery to identify and address misconceptions.

In this study, teachers were encouraged to scaffold curriculum for the success of their dual enrollment students, and we found that all teachers utilized scaffolding to some degree. However, this added support became a concern later in the semester when schools fell behind pacing milestones, and scheduling adjustments were implemented to finish on schedule. It is recommended that teachers continue to provide scaffolding throughout the course while also working closely with the instructor of record for suggestions on time allotments.

Tech 120: Design Thinking in Technology is a required course for any Purdue Polytechnic Institute major, and is one of three course needed for a design and innovation minor. To help teachers see the significance of such a course, and convey that with their students who may have experienced courses that have a similar design focus, the research team chose to incorporate both an alumni panel, and a Purdue faculty panel. While these panels were not directly linked to the curriculum the teachers would be facilitating, they acted to lend the program credibility, and allowed the teachers the opportunity to ask questions and form a bigger picture of how this course may prepare their students. It is recommended that future professional learning experiences utilize faculty and student alumni panels, especially when introducing new teachers to the dual credit curriculum. It is further recommended that these panels be recorded, as faculty may not be willing to participate on an long-term on-going basis.

Navigating course content, and specifically the Implementation Plan, was challenging for all teachers throughout the summer and school year. While time was provided for teachers to look over the documents and learning management systems during the professional development, this was largely unstructured and teachers may not have known at that time if they were having difficulty, or if they needed help. A recommendation for future professional developments would be to have a structured time for teachers to find various information that they would need on a weekly basis in the form of a digital scavenger hunt. It would further be recommended to lead a discussion for each successfully located item to identify where teachers found the information, and what steps they used to get there.

With evaluating students, there were very few discrepancies between the instructor of record and the facilitating teachers. There were, however, more complicated rubrics at the end of the semester that multiple teachers requested help interpreting. As these were rubrics that were selected and reviewed during the professional learning experience, it would seem that teachers were either unwilling to voice their questions, or they did not realize they had a question until later in the year. It is recommended for future professional developments that more complicated rubrics are read through one line at a time, pausing for teachers to state their interpretation of requirements for each line item, and coming to consensus before moving on to the next.

There seemed to be a misunderstanding in the professional development when it came to reviewing preparatory materials and supplemental readings before participating in teacher-led lessons. It was found later that some facilitators continued to avoid this preparatory work into the school year. These same teachers stated how useful they felt the information was when they completed the readings with their students and requested that prep work should have a more prominent role in professional development. It is recommended that teachers be encouraged both during the professional learning experience and throughout the school year to engage in both the student and teacher sides of the curriculum.

The theme of the mini-design challenge that teachers were to complete before the workshop elicited mixed reactions. Many felt that completing the project was worthwhile, especially as it became a reoccurring theme for lessons they would teach or assignments they would complete throughout the week but noted that the theme was too close to home. While the theme, *How might we better transition new students into your school*, was intended to provide strategies for teachers to work with new students, the wording led them to reflect on how little

control they had over the school environment. It is recommended for future professional developments to continue providing a pre-workshop assignment, but to modify the theme such that teachers could connect and benefit from it. One suggestion might be *What strategies might you employ to provide students a more active role in your classroom?* This would not only provide potential strategies for teachers to utilize in their classrooms, but it would shift the focus to something teachers have immediate control over.

The research team was proactive in sending information about the workshop early and often throughout the spring semester to prepare teachers for what to expect in the summer. Our group of participants needed to set up a Purdue account, set up an email, log into a new learning management system, install a Microsoft Teams application, and sign participant consent forms. However, it is easy for emails to become overlooked, set aside, and buried under new messages. One recommendation would be to provide teachers with a checklist of items to complete before attending the professional development, and that this checklist be included on each email notification. It is further recommended that individual items on the checklist are appended with the date of the corresponding emails such that teachers could find more details and context.

Many teachers commented thought the school year and professional development that they appreciated seeing and hearing strategies others were using in their classrooms. It is recommended to create and cultivate a list of tools, resources, and strategies to incorporate into a teachers' guide.

The activity that all teachers shared as the experience that prepared them the most for teaching this course, both concluding the professional development and throughout the semester, was modeling lessons during the professional learning experience. These lessons were constantly referred back to during weekly meetings, and teachers expressed the most confidence and connection with the lessons they taught or participated in. It is therefore highly recommended that this remain an integral component of the professional learning experience.

Finding ways to convey the sequence of lessons can be challenging, and at least one teacher expressed that they were unsure of the bigger picture when participating in the professional development. For the dual credit course, this concern is addressed with students through the incorporation of Gantt charts for the second and final projects. As teachers indicated an appreciation of this form of communication, it is recommended that a course level Gantt chart

be used throughout the professional development, focusing on when major skills are iterated on throughout the semester.

5.3 Implications for the Field

Covid-19 presented many unforeseen obstacles. Professional development was delivered virtually to a group of teachers that did not receive a break from their school year. Teachers and students adopted and implemented a new learning management system utilizing content, rubrics, submissions, and gradebook. Covid-19 procedures resulted in the class being taught face-to-face, virtually, and some combination of the two complicating both the facilitation of lessons and completion of assignments. Student attendance was inconsistent, and one of the teachers even quarantined for over a week as a precaution due to Covid-19 procedures. Any one of these factors would be cause for alarm when implementing a new curriculum, and yet teachers successfully delivered course content, students were held accountable for their learning, and not a single student who completed the course for dual credit earned below a 'C'.

For colleges and universities looking to implement a facilitator model, it is important to note and differentiate the amount of time and resources required between the ramp-up phase, to initiate such a program, and maintaining the program over time. Piloting a facilitator model program requires attention to details such as the recruitment, registration, professional development, and on-going support. The researcher found that this consumed more time compared to the level of commitment for a normal college section. However, maintaining the course over time is not expected to take any more time than a normal college section, as teachers will have developed more confidence with the coursework, and many of the supports can be re-implemented from the piloting of the course.

The facilitator model provided both students and teachers with ongoing support, resources, and teaching strategies to navigate the many obstacles that appeared throughout the course of the semester. Teacher facilitators had the privilege of collaborating with the university to provide scaffolding and lesson modifications, ensuring confidence in a fidelity of implementation. As an instructor of the Tech 120: Design Thinking in Technology curriculum, the researcher can attest to the fact that student performance was similar, and at times perhaps high school students outperformed their on-campus peers.

Other studies have shown the efficacy of the facilitator model in highly structured math courses (L. J. Pyzdrowski et al., 2006, 2011, 2016). Conclusions drawn from this study indicate that the facilitator model can also be effective in open-ended design courses, even in adverse circumstances.

5.4 Recommendations for Future Research

This research focused on identifying strategies and supports to meet the needs of teachers facilitating a dual credit course. Whether it be access to course content, challenges with the curriculum, or quality of assignments, throughout the study the student performance acted as an indicator of teacher needs. Therefore, the following are recommendations for future research:

1.) While students succeeded in all five teachers' classes, each teacher provided a different level of support. The spectrum included teachers that graded students more harshly and provided little in terms of reminders, pushing students toward independence, teachers that provided multiple emails and updates of what was coming up next and one-on-one scaffolding, and teachers that fell somewhere in the middle. A longitudinal investigation into the successes and struggles in first two years of students who matriculate to a major university after matriculating from a facilitator model program is recommended to further refine supports for teacher facilitators.

2.) Teachers in this study indicated that the support of the Student Success Coach was a major factor to their confidence and student success rate, but if they were to teach the course again, they would not need the same level of support. A follow-up study of the needs of the same teachers after completing three (3) and five (5) semesters would provide a more accurate indication of the amount of resources required to scale up such a program.

3.) Another potential study may include an investigation of the calibration between the instructor of record and the facilitating teacher. Potential research questions may consist of: How and in what ways do teacher and instructor of record need to calibrate feedback with each other? What are the impacts on students when the teacher and instructor of record are not calibrated?

4.) In this study, the roles of the researcher, instructor of record, and Student Success Coach were all carried out by the same individual. While it was found to be advantageous for providing supports to have the same person act as the Student Success Coach and instructor of record, this level of support is likely not scalable. Future studies may investigate the

effectiveness of a facilitator model with the roles of the instructor of record and Student Success Coach fulfilled by different individuals.

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APPENDIX A. INITIAL DATABASES SEARCH STRATEGY

Search String: (Facilitator OR Blended Modality OR Co-teaching Model) AND (Professional Development OR Teacher Training OR Summer Training) AND (Dual Credit OR College Credit OR Transfer Credit)

Search 1: Engineering Village – 22 – Results - High Quality

Search 2: Proquest – 2529 Results - Low Quality

Search 3: Scopus – 0 Results

Search 4: Web of Science – 3 Results – 1 High Quality

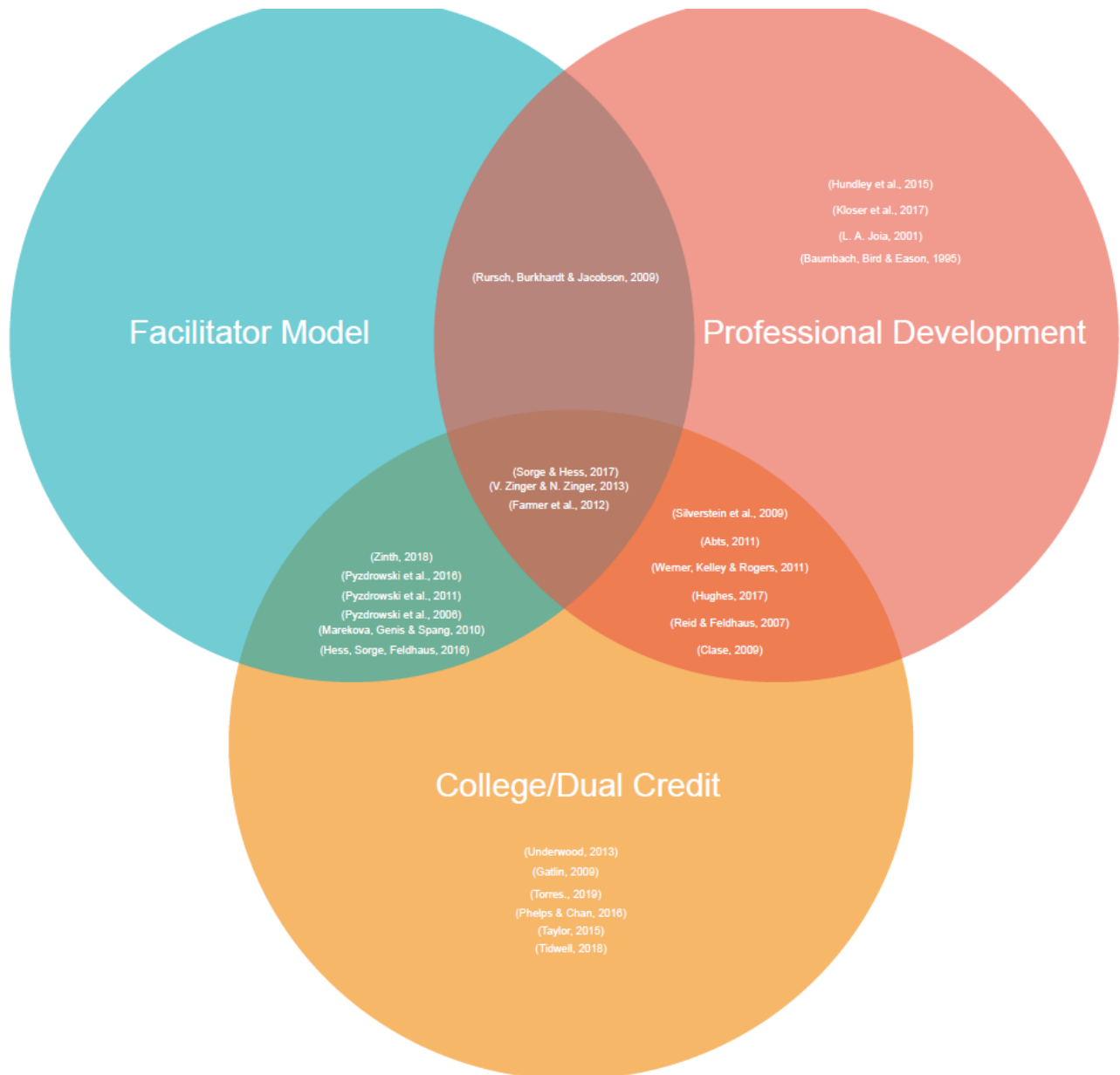
Search 5: ERIC (EBSCO) – 21,102 Results

APPENDIX B. BIBLIOGRAPHY OF MOST IMPORTANT INITIAL SOURCES

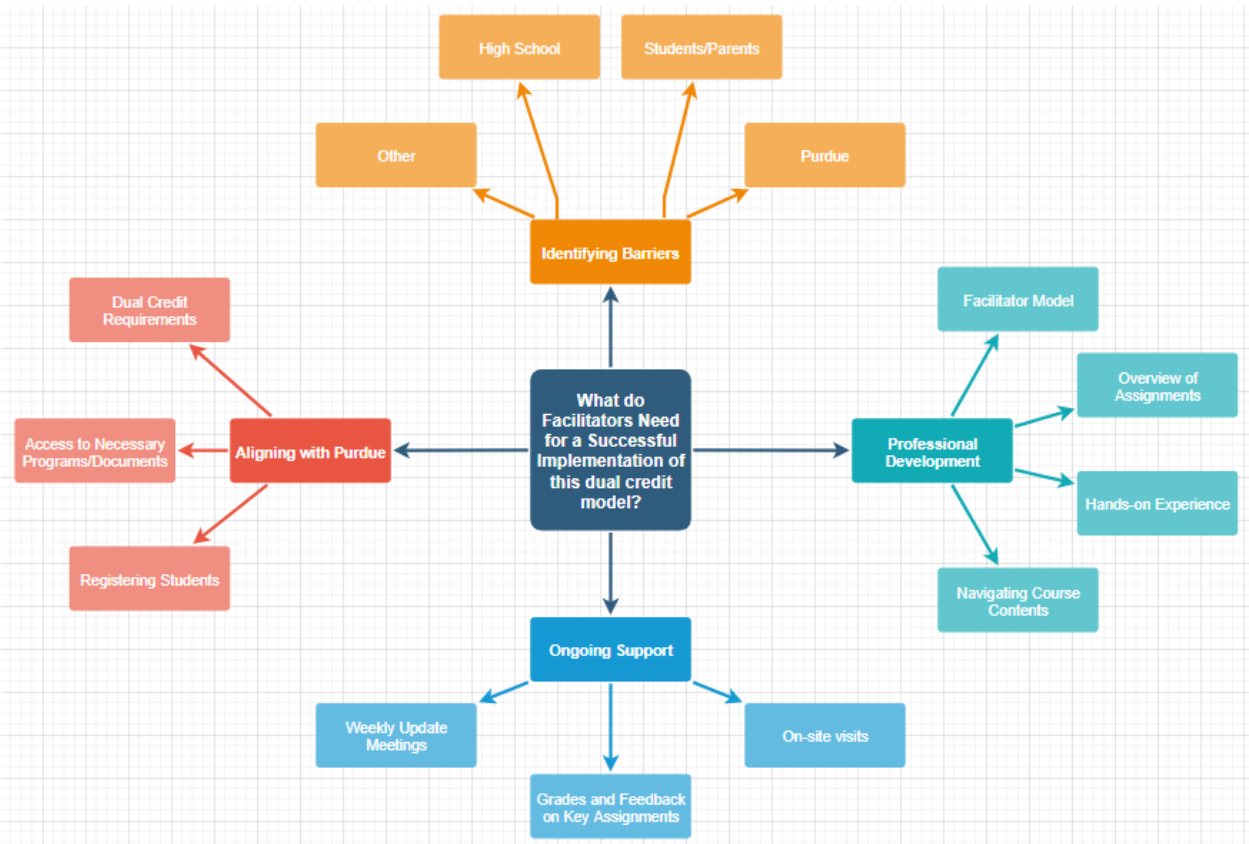
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APPENDIX C. INITIAL RESEARCH VENN DIAGRAM



APPENDIX D. PERCEIVED NEED FLOWCHART



APPENDIX E. EVALUATING PROFESSIONAL DEVELOPMENT INSTRUMENT

Figure 1. Five Levels of Professional Development Evaluation

Evaluation Level	What Questions Are Addressed?	How Will Information Be Gathered?	What Is Measured or Assessed?	How Will Information Be Used?
1. Participants' Reactions	<p>Did they like it?</p> <p>Was their time well spent?</p> <p>Did the material make sense?</p> <p>Will it be useful?</p> <p>Was the leader knowledgeable and helpful?</p> <p>Were the refreshments fresh and tasty?</p> <p>Was the room the right temperature?</p>	Questionnaires administered at the end of the session	Initial satisfaction with the experience	To improve program design and delivery

www.ascd.org/publications/educational-leadership/mar02/vol59/num06/Does-It-Make-a-Difference-Evaluating-Professional-Development.aspx

2/10

	Were the chairs comfortable?			
2. Participants' Learning	Did participants acquire the intended knowledge and skills?	Paper-and-pencil instruments Simulations Demonstrations Participant reflections (oral and/or written) Participant portfolios	New knowledge and skills of participants	To improve program content, format, and organization
3. Organization Support & Change	Was implementation advocated, facilitated, and supported? Was the support public and overt? Were problems addressed quickly and efficiently? Were sufficient resources made available? Were successes recognized and shared? What was the impact on the organization? Did it affect the organization's	District and school records Minutes from follow-up meetings Questionnaires Structured interviews with participants and district or school administrators Participant portfolios	The organization's advocacy, support, accommodation, facilitation, and recognition	To document and improve organization support To inform future change efforts

	climate and procedures?			
4. Participants' Use of New Knowledge and Skills	Did participants effectively apply the new knowledge and skills?	<p>Questionnaires</p> <p>Structured interviews with participants and their supervisors</p> <p>Participant reflections (oral and/or written)</p> <p>Participant portfolios</p> <p>Direct observations</p> <p>Video or audio tapes</p>	Degree and quality of implementation	To document and improve the implementation of program content
5. Student Learning Outcomes	<p>What was the impact on students?</p> <p>Did it affect student performance or achievement?</p> <p>Did it influence students' physical or emotional well-being?</p> <p>Are students more confident as learners?</p> <p>Is student attendance improving?</p>	<p>Student records</p> <p>School records</p> <p>Questionnaires</p> <p>Structured interviews with students, parents, teachers, and/or administrators</p> <p>Participant portfolios</p>	<p>Student learning outcomes:</p> <p>Cognitive (Performance & Achievement)</p> <p>Affective (Attitudes & Dispositions)</p> <p>Psychomotor (Skills & Behaviors)</p>	<p>To focus and improve all aspects of program design, implementation, and follow-up</p> <p>To demonstrate the overall impact of professional development</p>

4/27/2020

Does It Make a Difference? Evaluating Professional Development - Educational Leadership

	Are dropouts decreasing?			
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APPENDIX F. DET INSTRUMENT TO EVALUATE UNDERSTANDING OF DESIGN THINKING

Factor 1: Importance of DET (alpha= 0.91)	Factor Loadings	Mean (SD) 1-4 scale
I would like to be able to teach my students to understand the use and impact of DET	0.830	3.51 (0.70)
I would like to be able to teach my students to understand the science underlying DET	0.743	3.52 (0.70)
I would like to be able to teach my students to understand the design process	0.730	3.47 (0.72)
I would like to be able to teach students to understand the types of problems to which DET can be applied	0.726	3.57 (0.65)
My motivation for teaching science is to promote an understanding of how DET affects society	0.672	3.26 (0.79)
I am interested in learning more about DET through in-service	0.665	3.30 (0.79)
I would like to be able to teach students to understand the process of communicating technical information	0.659	3.48 (0.68)
My motivation for teaching science is to prepare young people for the world of work	0.652	3.53 (0.67)
My motivation for teaching science is to promote an enjoyment of learning	0.599	3.81 (0.47)
I believe DET should be integrated into the K-12 curriculum	0.592	3.56 (0.68)
I am interested in learning more about DET through workshops	0.591	3.39 (0.82)
I am interested in learning more about DET through college courses	0.581	2.95 (0.98)
In a science curriculum, it is important to include the use of engineering in developing new technologies	0.572	3.33 (0.79)
I am interested to learning more about DET through peer training	0.564	3.14 (0.90)
My motivation for teaching science is to help students develop an understanding of the technical world	0.511	3.72 (0.45)
My motivation for teaching science is to educate scientists, engineers and technologists for industry	0.459	3.02 (0.86)
In a science curriculum, it is important to include planning of a project	0.435	3.70 (0.52)
How important should pre-service education be for teaching DET?	0.418	3.45 (0.72)
Factor 2: Familiarity with DET (alpha= 0.83)		
How familiar are you with DET?	0.747	2.56 (1.01)
Have you had any specific DET courses outside of your pre-service curriculum?	0.652	1.83 (1.03)
How confident do you feel about integrating more DET into your curriculum?	0.646	2.89 (0.95)
Barrier in integrating DET - lack of teacher knowledge	0.602	1.94 (0.84)
Was your pre-service curriculum effective in supporting your ability to teach DET at the beginning of your career?	0.601	1.78 (1.00)
Did your pre-service curriculum include any aspects of DET?	0.569	1.91 (1.02)

Table 2. Factor loading, means, and standard deviations of 41 survey items. (continues)

Barrier in integrating DET - lack of training	0.567	1.79 (0.86)
I use DET activities in the classroom	0.561	2.66 (0.93)
Barrier in integrating DET - lack of time for teachers to learn about DET	0.560	1.68 (0.79)
I know the national science standards related to DET	0.516	2.13 (0.92)
Barrier in integrating DET - lack of administration support	0.448	2.51 (1.00)
My school supports DET activities	0.429	2.76 (1.07)
Factor 3: Stereotypical Characteristics of Engineers (alpha= 0.76)		
A typical engineer has good verbal skills	0.734	2.73 (0.86)
A typical engineer works well with people	0.691	2.62 (0.88)
Most people feel that minority students can do well in DET	0.686	2.71 (0.89)
Most people feel that female students can do well in DET	0.662	2.58 (0.92)
A typical engineer has good writing skills	0.620	2.92 (0.78)
Factor 4: Characteristics of Engineering (alpha= 0.66)		
Most people feel that male students can do well in DET	0.668	3.59 (0.55)
A typical engineer does well in science	0.614	3.47 (0.66)
A typical engineer has good math skills	0.450	3.87 (0.34)
A typical engineer earns good money	0.423	3.62 (0.57)
A typical engineer likes to fix things	0.413	3.42 (0.66)
DET has positive consequences for society	0.390	3.61 (0.72)
Overall alpha for 41-item survey = 0.88		

Table 2. Factor loading, means, and standard deviations of 41 survey items. (continued)

APPENDIX G. WILDER COLLABORATION INSTRUMENT TO MEASURE READINESS FOR COLLABORATION

The Wilder Collaboration Factors Inventory

Name of Collaboration Project _____

Date _____

Statements about Your Collaborative Group:

Factor	Statement	Strongly Disagree	Disagree	Neutral, No Opinion	Agree	Strongly Agree
History of collaboration or cooperation in the community	1. Agencies in our community have a history of working together	1	2	3	4	5
	2. Trying to solve problems through collaboration has been common in this community. It's been done a lot before.	1	2	3	4	5
Collaborative group seen as a legitimate leader in the community	3. Leaders in this community who are not part of our collaborative group seem hopeful about what we can accomplish.	1	2	3	4	5
	4. Others (in this community) who are not a part of this collaboration would generally agree that the organizations involved in this collaborative project are the "right" organizations to make this work.	1	2	3	4	5
Favorable political and social climate	5. The political and social climate seems to be "right" for starting a collaborative project like this one.	1	2	3	4	5
	6. The time is right for this collaborative project.	1	2	3	4	5
Mutual respect, understanding, and trust	7. People involved in our collaboration always trust one another.	1	2	3	4	5
	8. I have a lot of respect for the other people involved in this collaboration.	1	2	3	4	5
Appropriate cross section of members	9. The people involved in our collaboration represent a cross section of those who have a stake in what we are trying to accomplish.	1	2	3	4	5
	10. All the organizations that we need to be members of this collaborative group have become members of the group.	1	2	3	4	5
Members see collaboration as in their self-interest	11. My organization will benefit from being involved in this collaboration.	1	2	3	4	5
Ability to compromise	12. People involved in our collaboration are willing to compromise on important aspects of our project.	1	2	3	4	5
Members share a stake in both process and outcome	13. The organizations that belong to our collaborative group invest the right amount of time in our collaborative efforts.	1	2	3	4	5

Factor	Statement	Strongly Disagree	Disagree	Neutral, No Opinion	Agree	Strongly Agree
	14. Everyone who is a member of our collaborative group wants this project to succeed.	1	2	3	4	5
	15. The level of commitment among the collaboration participants is high.	1	2	3	4	5
Multiple layers of participation	16. When the collaborative group makes major decisions, there is always enough time for members to take information back to their organizations to confer with colleagues about what the decision should be.	1	2	3	4	5
	17. Each of the people who participate in decisions in this collaborative group can speak for the entire organization they represent, not just a part.	1	2	3	4	5
Flexibility	18. There is a lot of flexibility when decisions are made; people are open to discussing different options.	1	2	3	4	5
	19. People in this collaborative group are open to different approaches to how we can do our work. They are willing to consider different ways of working.	1	2	3	4	5
Development of clear roles and policy guidelines	20. People in this collaborative group have a clear sense of their roles and responsibilities.	1	2	3	4	5
	21. There is a clear process for making decisions among the partners in this collaboration.	1	2	3	4	5
Adaptability	22. This collaboration is able to adapt to changing conditions, such as fewer funds than expected, changing political climate, or change in leadership.	1	2	3	4	5
	23. This group has the ability to survive even if it had to make major changes in its plans or add some new members in order to reach its goals.	1	2	3	4	5
Appropriate pace of development	24. This collaborative group has tried to take on the right amount of work at the right pace.	1	2	3	4	5
	25. We are currently able to keep up with the work necessary to coordinate all the people, organizations, and activities related to this collaborative project.	1	2	3	4	5
Open and frequent communication	26. People in this collaboration communicate openly with one another.	1	2	3	4	5

Factor	Statement	Strongly Disagree	Disagree	Neutral, No Opinion	Agree	Strongly Agree
	27. I am informed as often as I should be about what goes on in the collaboration.	1	2	3	4	5
	28. The people who lead this collaborative group communicate well with the members.	1	2	3	4	5
Established informal relationships and communication links	29. Communication among the people in this collaborative group happens both at formal meetings and in informal ways.	1	2	3	4	5
	30. I personally have informal conversations about the project with others who are involved in this collaborative group.	1	2	3	4	5
Concrete, attainable goals and objectives	31. I have a clear understanding of what our collaboration is trying to accomplish.	1	2	3	4	5
	32. People in our collaborative group know and understand our goals.	1	2	3	4	5
	33. People in our collaborative group have established reasonable goals.	1	2	3	4	5
Shared vision	34. The people in this collaborative group are dedicated to the idea that we can make this project work.	1	2	3	4	5
	35. My ideas about what we want to accomplish with this collaboration seem to be the same as the ideas of others.	1	2	3	4	5
Unique purpose	36. What we are trying to accomplish with our collaborative project would be difficult for any single organization to accomplish by itself.	1	2	3	4	5
	37. No other organization in the community is trying to do exactly what we are trying to do.	1	2	3	4	5
Sufficient funds, staff, materials, and time	38. Our collaborative group had adequate funds to do what it wants to accomplish.	1	2	3	4	5
	39. Our collaborative group has adequate "people power" to do what it wants to accomplish.	1	2	3	4	5
Skilled leadership	40. The people in leadership positions for this collaboration have good skills for working with other people and organizations.	1	2	3	4	5

APPENDIX H. RTOP OBSERVATION INSTRUMENT

Appendix 1. Matrix of Factor Pattern Coefficients

RTOP Item	Item No	Factor1	Factor2	Factor 3
The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	1	.60	.37	.29
The lesson was designed to engage students as members of a learning community.	2	.83	.08	.30
In this lesson, student exploration preceded formal presentation.	3	.86	.13	.09
This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	4	.84	.19	.16
The focus and direction of the lesson was often determined by ideas originating with students.	5	.72	.38	.29
The lesson involved fundamental concepts of the subject.	6	.06	.82	-.17
The lesson promoted strongly coherent conceptual understanding.	7	.19	.76	.12
The teacher had a solid grasp of the subject matter content inherent in the lesson.	8	.08	.64	.43
Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	9	.38	.56	.41
Connections with other content disciplines and/or real world phenomena were explored and valued.	10	.25	.64	.25
Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	11	.68	.16	.19
Students made predictions, estimations and/or hypotheses and devised means for testing them.	12	.83	.27	.03
Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.	13	.78	.29	.27
Students were reflective about their learning.	14	.78	.25	.20
Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	15	.79	.37	.28
Students were involved in the communication of their ideas to others using a variety of means and media.	16	.75	.22	.27
The teacher's questions triggered divergent modes of thinking.	17	.60	.46	.43
There was a high proportion of student talk and a significant amount of it occurred between and among students.	18	.76	.02	.46
Student questions and comments often determined the focus and direction of classroom discourse.	19	.65	.40	.42
There was a climate of respect for what others had to say.	20	.50	.16	.69
Active participation of students was encouraged and valued.	21	.66	.24	.57
Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.	22	.69	.43	.22
In general the teacher was patient with students.	23	.26	.19	.85
The teacher acted as a resource person, working to support and enhance student investigations.	24	.82	.02	.32
The metaphor "teacher as listener" was very characteristic of this classroom.	25	.73	.12	.48

Appendix I. The Reformed Teaching Observation Protocol

Reformed Teaching Observation Protocol (RTOP)

Daiyo Sawada
External Evaluator

Michael Pibum
Internal Evaluator

and

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom
Evaluation Facilitation Group (EFG)

Technical Report No. IN00-1
Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher _____ Announced Observation? _____
(yes, no, or explain)
Location of class _____
(district, school, room)
Years of Teaching _____ Teaching Certification _____
(K-8 or 7-12)
Subject observed _____ Grade level _____
Observer _____ Date of observation _____
Start time _____ End time _____

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

BEST COPY AVAILABLE



Record here events that may help in documenting the ratings.

Time	Description of Events

III. LESSON DESIGN AND IMPLEMENTATION

		Never Occurred				Very Descriptive
1)	The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	0	1	2	3	4
2)	The lesson was designed to engage students as members of a learning community.	0	1	2	3	4
	In this lesson, student exploration preceded formal presentation.					
3)		0	1	2	3	4
4)	This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	0	1	2	3	4
5)	The focus and direction of the lesson was often determined by ideas originating with students.	0	1	2	3	4

IV. CONTENT

Propositional knowledge

6)	The lesson involved fundamental concepts of the subject.	0	1	2	3	4
7)	The lesson promoted strongly coherent conceptual understanding.	0	1	2	3	4
8)	The teacher had a solid grasp of the subject matter content inherent in the lesson.	0	1	2	3	4
9)	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	0	1	2	3	4
10)	Connections with other content disciplines and/or real world phenomena were explored and valued.	0	1	2	3	4

Procedural Knowledge

11)	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	0	1	2	3	4
12)	Students made predictions, estimations and/or hypotheses and devised means for testing them.	0	1	2	3	4
13)	Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.	0	1	2	3	4
14)	Students were reflective about their learning.	0	1	2	3	4
15)	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	0	1	2	3	4

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Continue recording salient events here.

Time	Description of Events

V.

CLASSROOM CULTURE

	Communicative Interactions	Never Occurred	Very Descriptive
16)	Students were involved in the communication of their ideas to others using a variety of means and media.	0 1 2 3 4	
17)	The teacher's questions triggered divergent modes of thinking.	0 1 2 3 4	
18)	There was a high proportion of student talk and a significant amount of it occurred between and among students.	0 1 2 3 4	
19)	Student questions and comments often determined the focus and direction of classroom discourse.	0 1 2 3 4	
20)	There was a climate of respect for what others had to say.	0 1 2 3 4	

Student/Teacher Relationships

21)	Active participation of students was encouraged and valued.	0 1 2 3 4	
22)	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.	0 1 2 3 4	
23)	In general the teacher was patient with students.	0 1 2 3 4	
24)	The teacher acted as a resource person, working to support and enhance student investigations.	0 1 2 3 4	
25)	The metaphor "teacher as listener" was very characteristic of this classroom.	0 1 2 3 4	

Additional comments you may wish to make about this lesson.

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APPENDIX I. PROJECT SPECIFIC QUESTIONS

Project Specific Questions

What are you most hoping to learn from this week?

What parts of the design thinking curriculum do you feel most comfortable with?

What made these professional development sessions effective?

I suggest changing/improving this professional development by....

What parts of the design thinking curriculum do you anticipate challenges with?

In what ways did ongoing support throughout the academic year meet your needs?

How and in what ways has the student success coach been helpful in this course?

APPENDIX J. LETTER OF COOPERATION



Date: 4/26/2020

Re: Letter of Cooperation from

Dear Dr. Nathan Mentzer,

This letter confirms that I, as an authorized representative of the _____, allow your research team (*Dr. Nathan Mentzer, Dr. Greg Strimel, Dr. David Sears, and Mr. Scott Thorne*) access to conduct study related activities throughout the implementation of the TECH 12000 course, as discussed with the Principal Investigator and briefly outlined below, and which may commence when the Principal Investigator provides documentation of IRB approval for the proposed project.

- **Study Title:** *HS Facilitator Model 2020 Teacher Development*
- **Study Activities Occurring at this Site:** *The research team will conduct observations and collect teacher generated artifacts (notes from group interactions, design documentation, and prototypes) during the TECH 12000 professional development. Also, the team will conduct observations while the teachers deliver their TECH 12000 lessons in their classrooms as well as carry out interviews, both individual and group, throughout the research period. Lastly, questionnaires will be distributed to the teachers at the beginning and end of the professional development as well as at the beginning and end of the semester. The research team hopes that these data will aid in discovering key needs, and supports to meet these needs, to best prepare teachers to provide dual credit pathways.*
- **Site Support:** *High Schools will provide connections with the teachers for data collection and support teacher participation in the dual credit program.*
- **Other:** *After the study is complete, the research team will present a summary of the results to relevant High School stakeholders, following the appropriate protocol to protect the confidentiality of the participants.*
- **Anticipated End Date:** *3/31/2021*

I understand that any activities involving compliance with Health Insurance Portability and Accountability Act (HIPAA), Family Educational Rights and Privacy Act (FERPA), or other applicable regulations at this site must be addressed prior to granting permission to the Purdue University researcher to collect or receive data from the site. I am authorized to make this determination on my organization's behalf.

We understand that _____ participation will only take place during the study's active IRB approval period. All study related activities must cease if IRB approval expires or is suspended. If we have any concerns related to this project, we will contact the Principal Investigator who can provide the information about the IRB approval. For concerns regarding IRB policy or human subject welfare, we may also contact the Purdue University IRB at irb@purdue.edu (www.irb.purdue.edu).

APPENDIX K. PARTICIPANT CONSENT FORM - INSTRUCTOR

RESEARCH PARTICIPANT CONSENT FORM - INSTRUCTOR

Dr. Nathan Mentzer
Technology Leadership and Innovation
Purdue University

Key Information

Please take time to review this information carefully. This is a research study. Your participation in this study is voluntary which means that you may choose not to participate at any time without penalty or loss of benefits to which you are otherwise entitled. You may ask questions to the researchers about the study whenever you would like. If you decide to take part in the study, you will be asked to sign this form, be sure you understand what you will do and any possible risks or benefits. You will be prepared to facilitate the curriculum for Purdue's Tech 120 - Design Thinking in Technology course, and this study will help researchers investigate dual credit models for direct credit transfer. The duration of this study is one academic year. Potential risks are no greater than normal classroom activities but could include a breach of confidentiality. Potential benefits may include improvement in student learning, motivation and self-efficacy while also allowing students to earn direct college credit through Purdue University.

What is the purpose of this study?

College access remains a priority for Indiana, specifically for minoritized urban youth. While it seems as though is well on its way to prepare more students for the future of learning and work, Purdue may not be positioned to yield students who might qualify for admissions to Purdue and have interest in pursuing higher education. By establishing the

Purdue program, students will (1) be supported in the transition to a large university while they are in high school with their everyday teachers, (2) be provided with a true connection to the university, (3) make progress toward a degree by earning direct credit, (4) gain experiences that directly relate to college life at a large institution, and (5) likely, according to research, perform better on campus. Another benefit of this program is the high-potential for scalability to other schools throughout the state to support program sustainability. By participating in this research, we will gain a better understanding of how to support dual credit programs and scale up to include other schools after the study. We anticipate enrolling 10 teachers.

What will I do if I choose to be in this study?

During the professional development and implementation of the Tech120 course, we seek to collect data on teacher experiences, teacher learning, and implementation reflection. To gather these data, we will:

1. Conduct individual and group interviews about design thinking, collaboration and professional development experiences.
2. Conduct surveys about design thinking, collaboration and professional development experiences.
3. Conduct observations of the teacher during the professional development and while facilitating the course.
4. Collect teacher design work artifacts such as design journals, notes, prototypes.
5. Collect teacher lesson plans including how Tech120 is adapted to fit the school structure.
6. Collect teacher evaluation of deidentified student work.

How long will I be in the study?

This is a one-year engagement with the school.

What are the possible risks or discomforts?

No risks greater than those experienced in ordinary classroom learning and teaching environments are anticipated.

Are there any potential benefits?

This program has a high-potential for scalability to other schools throughout the state to support program sustainability and expand on mission to develop a new generation of skilled talent by seamlessly transitioning students from high school to college to high-tech and/or high-wage jobs. Also, this program can help facilitate College of Education preservice teacher placements in schools, thereby offering a pathway for Purdue students to future careers at . During the conversations with researchers and colleague teachers, you will have the opportunity of hearing from other instructors about their teaching strategies, plans, and experiences. You may also have the chance to share your own experiences. Your

participation may benefit you, other instructors, and future instructors of these courses. Your experience could also aid future students by offering more opportunities for obtaining college credits.

Will I receive payment or other incentive?

No.

Will information about me and my participation be kept confidential?

No names or identifying information will be archived from our observations or interactions. Data will be kept on password-protected computers. Audio recordings will be stored on a hard drive shared by the research team. Video recordings will be deidentified using facial blur technology. Data will be kept for 5 years after the project is complete. Only the research team will have access to the data for analysis purposes. The project's anonymized research records may be reviewed by departments at Purdue University responsible for regulatory and research oversight.

What are my rights if I take part in this study?

Your participation in this study is voluntary. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled. Your position and evaluation as an instructor will not be affected by whether or not you participate in this study. If you withdraw prior to the end of the study, any materials provided by the research team must be returned.

Who can I contact if I have questions about the study?

If you have questions, comments or concerns about this research project, you can talk to one of the researchers. Please contact Dr. Nathan Mentzer, nmentzer@purdue.edu, 765.494.0298.

If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Human Research Protection Program at (765) 494-5942, email (irb@purdue.edu) or write to:

Human Research Protection Program - Purdue University
Ernest C. Young Hall, Room 1032
155 S. Grant St.
West Lafayette, IN 47907-2114

Documentation of Informed Consent

I have had the opportunity to read this consent form and have the research study explained. I have had the opportunity to ask questions about the research study, and my questions have been answered. I am prepared to participate in the research study described above. I will be offered a copy of this consent form after I sign it.

Participant's Signature

Date

Participant's Name

Researcher's Signature

Date

APPENDIX L. TEACHER RECRUITMENT SCRIPT

Teacher recruitment script (shared at professional development):

We are conducting research _____ to evaluate and improve the professional development and dual credit implementation of Tech120. We need the help of teachers who are involved with the _____ Purdue Project to provide insight into their experiences.

During the professional development and implementation of the Tech120 course, we seek to collect data on teacher experiences, teacher learning and implementation reflection. To gather these data, we will:

1. Conduct individual and focus group interviews with teachers about design thinking, collaboration and professional development experiences.
2. Survey teachers about design thinking, collaboration and professional development experiences.
3. Conduct observations of teachers during the professional development and while teaching in their classrooms.
4. Collect teacher design work artifacts such as design journals, notes, prototypes.
5. Collect teacher lesson plans including how Tech120 is adapted to fit the school structure.
6. Collect teacher evaluation of deidentified student work.

Your participation is voluntary and you may choose to stop at any time. Your participation may lead to improvements in the _____ program. If you would like to participate or would like more information please contact me (Nathan Mentzer) via email at nmentzer@purdue.edu.

At this time, I'd like to pass out the Consent form and discuss it with you. If you are interested in participating in the research, please sign the consent document and return it to me.

Thank you!

VITA

Scott T Thorne

Education

M.S. Technology Leadership and Innovation, Purdue University, 2021

B.S. Engineering and Technology Education, Purdue University, 2009

Publications

Thorne, S., Mentzer, N., Strimel, G. J., & Sears, D. (2021). Facilitator Model for Dual Credit.

Bartholomew, S. R., Mentzer, N., Jones, M., Farrington, S., Johnson, N., Mohandas, L., & Thorne, S. (2019). Learning by Evaluating: Using Adaptive Comparative Judgment. Nashville, Tennessee. *106th Mississippi Valley Technology Teacher Education Conference and the 57th Southeastern Technology Education Conference.*

Teaching Impact

Experience

Design Thinking in Technology Instructor, Purdue University August 2019 – Present

- o Taught six sections of TECH 120 – Design Thinking in Technology
- o Collaborated with other TECH 120 instructors to maintain quality of coursework
- o Coached teams of students in Design Innovation Competitions in Fall 2019, Spring 2020, and Spring 2021

Researcher, Purdue University June 2020 – December 2020

- o Co-delivered professional development to high school teachers with a team of TLI and EDCI professors
- o Acted as the instructor of record for the facilitation of dual credit to a group of high school students
- o Met weekly with high school teachers throughout the fall semester to provide continued professional development

Teacher, Franklin Central High School July 2018 – May 2019

- o Taught Introduction to Engineering Design (IED) and Manufacturing
- o Developed Manufacturing curriculum
- o Started and was an Advisor a new Technology Student Association chapter
- o Mentored with the VEX Robotics club

Teacher, Burlington Community High School August 2011 to May 2018

- Taught Introduction to Engineering Design (IED), Engineering Design and Development (EDD), Computer Aided Drafting, Woodworking
- Developed Computer Aided Drafting Curriculum
- Collaborated with the Regional Advisory Committee on curriculum, expectations, and standards
- Technology Student Association Advisor

Manufacturing Engineering Intern, Winegard **May 2015 to October 2016 (summers)**

- Conducted time studies to implement new assembly lines
- Digitized data collection forms and formatted interactive charts and graphs as output in Microsoft Excel
- Headed the research team in purchasing new equipment for the plant floor
- Designed, prototyped, and implemented multiple problem-solving items for assembly line workers

Product Validation Engineering Intern, Case New Holland **May 2013 to October 2014**

- Created and updated Gantt charts of three major projects using Microsoft Project software
- Organized test lab data using charts and graphs in Microsoft Excel
- Oversaw and expedited progress of various tests to stay on schedule

Design Engineering Intern, Case New Holland **May 2012 to August 2012**

- Used Pro-E modeling software to create new part files, assemblies, and installation drawings
- Communicated progress and setbacks with project engineers in India
- Worked with data collection engineers in the test lab on multiple projects

Teacher, Hamilton Southeastern High School **August 2009 to May 2011**

- Taught Introduction to Engineering Design, Construction Systems, and Construction Processes
- Trained students in using Autodesk Inventor 3-D modeling software
- Coordinated two teams of students at the Northwest Indiana Project Lead the Way Competition

Student Teacher, Lafayette Jefferson High School **January 2009 to May 2009**

- Taught Transportation Systems, Construction Systems, and Aerospace Engineering
- Developed an alternative curriculum for Level I English Language Learners (ELL)
- Supported FIRST Robotics through chaperoning national competition
- Volunteered with students for a Habitat for Humanity build

Resident Assistant, Earhart Hall, Purdue University **January 2008 to May 2009**

- Enforced drug/alcohol policies and responded to frequent disciplinary situations
- Supported student development, engagement, and life-long learning through diverse programming activities
- Developed and maintained a positive learning environment for students of differing social, economic, and cultural backgrounds

Student Coordinator, Tarkington Hall, Purdue University

June 2006 to December 2007

- Trained, supervised, and supported student dining hall workers, as well as student supervisors
- Coordinated interview and selection process for hiring new staff
- Enforced policies of conduct and safety, conducted weekly evaluations, and offered feedback to management

Certifications and Training

- Mentor Teacher with the Teacher Leadership program 2017-2018
- Professional Learning Community Facilitator 2016-2018
- Project Lead the Way certifications in Gateway (MS), IED, Biotechnology, and EDD
- Completed coursework in Python and Raspberry Pi through Southeastern Community College
- Completed coursework in MasterCAM through the University of North Dakota
- Completed coursework in Laser Material Processing through Indian Hills Community College
- Completed coursework for AutoDesk Revit software through Ascent Center for Technical Knowledge
- Completed coursework in Advanced Inventor software training through Eastern Michigan University
- Completed coursework in Advanced Inventor software training through Ascent Center for Technical Knowledge
- Completed coursework in Professional Leadership Training at the National TSA Conference in Orlando, FL
- Attended workshops at the national convention for the Industrial Technology and Engineering Educators' Association

Awards and Recognition

- Published and Presented "Challenging the Dual Credit Status Quo" for the 2021 Annual Graduate Student Educational Research Symposium
- Published "Facilitator Model for Dual Credit" research brief for the 2021 Indiana STEM Education Conference
- Co-Presented "Synchronously Blending F2F and Remote Learners" at the 2021 Indiana STEM Education Conference
- Technology Student Association Board of Directors – Competitive Events Coordinator 2019 - Present
- Purdue Polytechnic Design Innovation Competition - **1st** place team Fall 2019
- Purdue Polytechnic Design Innovation Competition – **2nd** place team Spring 2020
- Teacher of the Year Nominee 2013, 2015
- Coached Students in the Technology Student Association

-3D **CAD State 1st** 2013, 2017, 2018, 2019

-Transportation Modeling **State 1st** 2013, 2014, 2015, 2016, 2017

-Structural Design and Engineering **State 1st** 2017, 2018, 2019

-Computer Integrated Manufacturing **State 1st** 2017, 2018, 2019

-3D CAD **National 1st** 2013

- Transportation Modeling **National 3rd** 2013
- Engineering Problem Solving **National 6th** 2014
- On Demand Video **National 7th** 2014
- Biotechnology **National 10th** 2017
- Iowa "Advisor of the Year" at 2014 National Conference
- Iowa "Advisor of the Year" at 2018 National Conference
- Jim Coffey Inspirational Teacher Award 2018
- Indiana "Rookie Chapter of the Year" 2019
- Indiana "Advisor of the Year" at 2019 National Conference
- Coached Students at the Northwest Indiana PLTW Competition
 - Best Overall Solution 2010
 - Best Design Documentation 2010

PUBLICATION

FACILITATOR MODEL FOR DUAL CREDIT

Scott Thorne, Technology Leadership and Innovation, Purdue University, sthorne@purdue.edu

Dr. Nathan Mentzer, Technology Leadership and Innovation, Purdue University, nmentzer@purdue.edu

Dr. Greg J. Strimel, Technology Leadership and Innovation, Purdue University, gstrimel@purdue.edu

Dr. David Sears, Educational Psychology and Research Methodology, Purdue University, dsears@purdue.edu

Few direct dual credit options exist for high schools working with major universities. Purdue University piloted a program, in 2020 using a facilitator model approach with five high school teachers. This model provided students an opportunity to earn directly transcribed college credits for a course that is a pre-requisite for all Polytechnic majors and is one of three courses necessary for a minor in design thinking. The facilitator model addresses many of the suggested changes to current dual credit models, including: ensuring credit transfer and articulation, affordability, accessibility, collaboration with the high school and college, and student supports. By addressing these barriers, successful incorporation of this model is likely to influence an increased enrollment and success of all students, including advancing equity for low-income and minority students.

The facilitator model differentiates itself from other dual credit models by providing intensive summer professional development and weekly on-going communication and support between the university and the secondary school instructors. This results in accountability for a fidelity of implementation, allowing students to earn directly transcribed college credits to major universities, as the same expectations and coursework are provided. Student work throughout the semester is validated daily by classroom teachers and periodically through ‘checkpoints’ by post-secondary instructors.

A qualitative case study was chosen to explore the needs of districts and teachers as facilitators of the college curriculum through both a summer professional development and ongoing support throughout the fall semester. Roughly 90 hours of qualitative data were collected and analyzed from five high school teachers including multiple interviews, focus groups, observations, questionnaires, and artifacts to draw conclusions on the needs and recommendations for implementation of a facilitator model dual credit course through the first

year of Purdue's collaborative research program. Both axial coding techniques and code-recode procedures were used to analyze the data. Findings support frequent communication, student feedback, and flexibility for teachers to scaffold and modify curriculum. Formal analysis is under way to investigate student self-efficacy, as well as supports for teachers utilizing the facilitator model.

The facilitator model differs from other dual credit models in the frequency of communication between the university and the high school. Our group of teachers met for 40-50 minutes weekly during a common time throughout the school day to discuss student progress, university alignment, checkpoints, strategies, and focus points for upcoming lessons. Teacher interview data suggested that while these meetings were recorded, having them synchronously was essential. On the facilitator model, one teacher noted "I know where to go. I don't feel like I'm alone on my raft. I feel like I know where to send questions and emails and someone's looking out for our students." Synchronous meetings allowed for direct answers to questions and teacher-to-teacher communication around the curriculum.

Literature about the facilitator model suggests that teachers as facilitators provide the initial feedback for students, encouraging corrections and modifications before submitting their work to each checkpoint. Students also indicated a positive impact on preparing for postsecondary education in end of course surveys. One noted, "It gave me a sense of what a college course would feel like, so I feel very prepared." As teachers frequently meet with a course coordinator from Purdue, questions and clarifications helped ensure alignment with university expectations. Our teachers also noted the advantages of a common time to collaborate with each other. As more schools participate, a greater network of expertise can be established for support with various approaches and scaffolding of the curriculum.