CHEMISTRY TUTORING MOTIVATIONS IN THE TIME OF THE PANDEMIC

by

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ABSTRACT

Tutoring is present on every university campus and available for nearly every discipline. Chemistry is no exception. The goal of this research study is to understand the motivations of chemistry students that are seeking tutoring during the first academic year of the COVID-19 pandemic. To accomplish this task, Self-Determination Theory was used to understand the extent to which the chemistry course did not satisfy the students' needs and how the participants felt these needs could be better satisfied through tutoring. Methodologically, this research is presented as a case study. This study set out to answer the following questions: What aspects of the chemistry course and content motivate tutees to seek out tutoring?; What aspects of the online learning environment created challenges that led tutees to seek out tutoring?; and What are the tutees' hopes and expectations of what tutoring can provide for them? It was found that many aspects of the course created an environment that left students with unsatisfied needs for competence, relatedness, and autonomy including but not limited to the lack of a relationship with their professor or TA and the amount of content the course presented. Many of these issues were bound up in the forced online nature of the course which did not provide enough scaffolding or relatedness-support leaving students desiring help. These results imply that students need more support in their courses, especially when those courses are online only. Support can take the form of more scaffolding in the course to help with issues of competence or reaching out to students and fostering communication amongst the students, professor, and TAs to support relatedness.

CHAPTER 1. INTRODUCTION

Tutoring is an ever-present part of the college experience, regardless of major or discipline. The demand for tutors and tutoring is growing as college classrooms become larger and the chance of interacting with the professor is becoming smaller (Por & Barriball, 2008; Topping, 1996). The last decades have seen a rise in various active learning strategies implemented in large lecture halls (Kovac, 1999; Ruder & Stanford, 2018) including having tutors and teaching assistants present during lecture (Chng et al., 2015). There is evidence that while active learning strategies are helpful in many cases, they are not a one-size-fits-all solution and some can actually increase student anxiety (K. M. Cooper et al., 2018). These in-class solutions are not the only way that the issue of learning in the modern collegiate culture can be addressed. Attention has also been paid to various resources that exist outside the lecture halls and still have a positive impact on student learning, including tutoring.

The modern research on tutoring came out of research done on supplemental instruction (SI) and various forms of informal, out-of-the-classroom learning opportunities (Abbot et al., 2018). Some examples of supplemental instruction include peer-led study groups, office hours with instructors or teaching assistants (TAs), and instructor/TA-led review sessions (Cole et al., 2018). However, these are not the only way that supplemental instruction, and tutoring in particular, has helped to fill the gaps left by large class sizes. Some of the most common and most effective strategies have been tutoring centers (Al Chibani, 2014; E. Cooper, 2010; Mynard & Almarzouqi, 2006) and one-on-one tutoring sessions (Agne & Muller, 2019; Herppich et al., 2016; Siler & VanLehn, 2015). The chemistry department at Purdue has a Chemistry Resource Room staffed by tutors, where students may drop-in and receive help, as well as a list of private tutors that students can contact for one-on-one tutoring (*Purdue University - Department of Chemistry - Welcome to the Chemistry Resource Room*, n.d.).

The benefits of tutoring have been well documented throughout the years (Ding & Harskamp, 2011). Some studies provide evidence that tutoring is more effective than traditional classroom learning (Bloom, 1984; P. A. Cohen et al., 1982; Graesser et al., 1995). Part of this, known as Bloom's 2 Sigma Problem, boils down to having a smaller student to teacher ratio results in more effective instruction (Bloom, 1984). As discussed previously, the student to teacher ratio is tending to grow larger and while it is beneficial for a student to receive more personal attention

from a teacher than less (Bloom, 1984), it is both impractical and unnecessary to claim that either tutoring or classroom learning is better or worse. As Raines (1994) writes, positioning tutoring and teaching as dichotomous is a narrow way of looking at the issue. Some researchers (Edmunds et al., 1990; Wolcott, 1989) position tutoring and teaching as a continuum in which it is possible to flow between these two supposed extremes on a spectrum, but Raines (1994) again finds this view to be lacking. Raines instead proposes viewing tutoring and teaching as dialectical, in constant conversation with each other, continually shaping and reshaping the other (Raines, 1994). Both tutoring and teaching thus have a place in education, each has a role that it plays, and both are important. For practitioners, experience tutoring can inform the way a teacher can approach situations with students, while experience teaching can alter the ways a tutor interacts with a tutee (Raines, 1994).

Not only has tutoring itself been shown to be effective, having a positive relationship with a tutor has been shown to have a positive impact on students, especially first year students (Yale, 2017). While there has been a decent amount of research concerning the teacher/student relationship, there is much less concerning the tutor/tutee relationship (Smith, 2011). Seeing as teaching and tutoring are not the same and are also not merely points upon a continuum (Raines, 1994), it stands to reason that the tutor/tutee relationship will differ from the teacher/student relationship. Much of what is known about tutor/tutee relationships comes from nursing education literature (Braine & Parnell, 2011). While this can help build a general picture of a tutor/tutee relationship, there will undoubtedly be differences between learning to be a nurse and learning in other contexts (Smith, 2011), making studies specific to those other contexts, such as chemistry tutoring, necessary. Because context always matters (Nolen, 2020), it is important to also discuss the ongoing context of the global pandemic.

In March of 2020, COVID-19 was officially declared a pandemic by the Centers for Disease Control (*WHO Director-General's Opening Remarks at the Media Briefing on COVID-*19 - 11 March 2020, n.d.) and colleges around the world were forced to adapt to an ongoing situation. For most, this meant a switch to an entirely online, virtual learning environment where in-person lectures and labs were replaced with distance learning (Marinoni et al., 2020). This massive, world-wide event introduced effects that permeated all aspects of this research study including the type of tutoring that tutees were able to engage in, the chemistry course itself, and the way in which this study had to be conducted.

1.1 Researcher Statement

I have a background as a chemistry tutor. I worked in a drop-in chemistry help room ran by the chemistry department at the community college I attended, Grossmont College, for two years. I worked an average of 10 hours per week there each semester. There was usually two tutors present and the amount of students ranged from as low as five to as high as 30-40 at any given time. I also worked in the general tutoring office at Grossmont College for three and a half years where students could make appointments for one-on-one time with a tutor typically for an hour, though students could select as little as half an hour or as much as two hours. While the amount of time I worked depended on students making appointments with me, I frequently worked up to 15 hours per week there. I tutored all levels of chemistry offered by the college, including several versions of introductory chemistry, general chemistry, and organic chemistry. I also tutored for an introductory philosophy course focused on logic. I have served as a private, one-on-one, tutor providing chemistry tutoring to students at both San Diego State University and Purdue University. I have tutored many students across multiple semesters from the general chemistry courses at Purdue University upon which this study focuses. Because I have spent a lot of time and effort on being a tutor and this research deals with tutoring, it is important to state my background as a tutor. This history provides me with both the motivation and prior knowledge necessary to perform the following study.

1.2 Scope of Study

This study took place at a large R1 land-grant university in the Midwest of the United States. The study took place during the first full academic year of the COVID-19 pandemic. This study was designed to investigate the motivations of first year general chemistry students in the non-major's course seeking chemistry tutoring. Part of the motivations focused on dealt with the overall chemistry course and how it made people feel like they needed tutoring. The online aspect of the course was focused upon in particular to understand how that unique context affected students. The final aspect was what the tutees wanted to get out of tutoring.

CHAPTER 2. LITERATURE REVIEW

This literature review was conducted and assembled in order to better understand the state of the literature in regards to a couple key points. The term *tutor* is used in several different contexts to refer to people with similar roles and it is important to understand how these roles relate to each other. Next, I want to understand how much of the tutoring literature overlaps with some of the key components of this research, namely the chemistry context and the qualitative nature of the research. Finally, it is important to understand what the literature has to say about the impact COVID-19 has had on education.

2.1 What is a Tutor?

There is a certain amount of ambiguity around the word *tutor* in the literature as it has been used to describe people with varying roles and activities. It has been used to describe more experienced students assisting in a classroom setting (Abbot et al., 2018; Colvin, 2007), someone performing any sort of SI or mentoring (Cole et al., 2018; Paukova et al., 2019), computer programs that act as a tutor (Rathod et al., 2019; Watkins & Krugh, 1986; S. White & Bodner, 1999), drop-in tutoring in a tutoring center where students can ask questions (E. Cooper, 2010), and one-on-one tutoring that generally lasts for an hour or more (Lu et al., 2007; VanLehn et al., 2003).

The literature frequently calls more experienced students present during the lecture of a lower level class tutors. In research done on peer tutors in a classroom, Abbot et al. (2018) describe the tutors as being present during lectures and having groups of students that the tutors would work with. The course was called the First Year Experience and helped students develop skills in discussion, reasoning, presenting, and writing. The author surveyed the tutors about what the tutors felt their primary roles in the classroom were. While eight total roles were identified, three stood out by having the largest percentage of tutors list them. 94% responded with "editing or commenting on student writing," 86% indicated "facilitating or participating in class discussions," and 73% said "managing classroom housekeeping (e.g. taking attendance, returning papers)" (Abbot et al., 2018). One of the main takeaways from this study was that the students acting as in-class tutors did not feel like they had a well-defined role in the classroom. In research done by

Colvin (2007) on peer tutoring, tutors worked with students in a classroom during lecture time in a communications class. It was found that the role of peer tutor was "not yet established" within the communications department and there was a lot of confusion over what it meant to be a tutor (Colvin, 2007, p. 172). One of the questions asked in the interviews pertained to whether the tutor saw a difference between being a tutor or being a TA (Table 1, p. 169), however this was not addressed in the paper itself (Colvin, 2007). This confusion over the difference between what it means to be a tutor and what it means to be TA is not surprising as graduate teaching assistants (GTAs) and in-class tutors share many similar roles.

For example, Gardner and Jones (2011) report that GTAs run recitation sessions, grade assignments for the class, and sometimes design their own curriculum; however, grading has been mentioned as a main in-class tutor task (Abbot et al., 2018), and running extra classes has been reported as something in-class tutors do as well (Graham et al., 2019). Similarly, both in-class tutors (Abbot et al., 2018) and GTAs (Dotger, 2011) have been positioned as acting as a link or translator between students and professors. Zotos et al. (2020) found the blur between in-class tutor and GTA present in their study as some GTAs self-identified as tutors. While the authors go on to state that GTAs are not just tutors as "they must focus on supporting students' learning of chemistry" (Zotos et al., 2020, p. 21), there is no reason to believe that "supporting students' learning of chemistry" is somehow a demarcating line between TA and tutor.

Modern research on tutoring has its roots in SI research and there continues to be a relationship between the two. Tutoring is a form of SI, yet it appears that anyone that performs SI is often labeled as a tutor. Cole et al. (2018) performed research on SI and how it impacted students in a freshman chemistry course for engineering students. Among the things they listed as SI were advanced undergraduate tutors in the College of Engineering Tutoring Office, a University Peer Tutoring Program, and review sessions ran by advanced undergraduate tutors, as well as office hours with either the TA or professor (Cole et al., 2018). They found that SI was beneficial to the students but they did not disaggregate their data to be able to tell which aspects of SI were useful (Cole et al., 2018). The usage of *tutor* in these instances is different from how tutor was used to talk about in-class assistants as their roles and their actions are not entirely the same. Another paper in which the term *tutor* seemed to encompass a large array of activities and roles was the autoethnography by Paukova, Khachaturova, and Safronov (2019). The tutors working with students in a master's program reported many activities beyond helping students with the content

of their courses such as attending meetings between their tutees and the tutees' advisor and mediating disputes between those two parties (Paukova et al., 2019). These tutors felt their role as tutor included being a mentor for their tutees by providing individual learning trajectories, career support, and psychological support (Paukova et al., 2019). Similarly, personal tutor literature from the UK (Gardner & Lane, 2010; Smith, 2011; Yale, 2017) refers to tutors in this expanded role of mentor with similarly expanded responsibilities. Clearly these types of tutors have roles that extend far beyond what in-class tutors have and further blur the line of what it means to be called a tutor.

The literature on computer programs, commonly called Intelligent Tutoring Systems (ITS), is surprisingly vast. If one includes not only research directly on the programs themselves but also research done on human tutors in the hopes of improving programs, ITS research makes up a large percentage of all tutoring research. Examples of ITS research done using human tutors will be explored later in this review. The Chemistry Tutor is the very first result in a search for tutor on the Journal of Chemistry Education website, and it is two reviews of a computer program that has three programs that show users how to balance equations and solve stoichiometric problems (Watkins & Krugh, 1986). The program does not sound capable of giving adaptive or tailored feedback, though it was designed more than 35 years ago so it is not surprising that it is fairly simplistic by today's standards. Another of the very first results in a search for *tutor* in the Journal of Chemistry Education is a review of a different program, CHEMiCALC (S. White & Bodner, 1999). While this program is capable of providing feedback such as "you are within $\pm 15\%$ " or "you are an order of magnitude away from the answer," that appears to be the extent of its ability to help (S. White & Bodner, 1999, p. 34). This may have been cutting edge in 1999 but the online homework most students encounter today is capable of this. A more recent entry into the literature combining chemistry and tutoring programs is research on a smartphone app called Titration ColorDarts (Rathod et al., 2019). This program uses a smartphone's camera to analyze how pink a titrated solution is and give a score out of 10 based on the shade of pink (Rathod et al., 2019). I fail to see how calling this program a tutor is valid. A tutor does more than merely grade a student's work. Calling either these programs or online homework a tutor is a massive misunderstanding of the benefit of tutoring. There is no denying that learning can occur from these types of situations, and I do not mean to make it seem as though there is no place in the literature for this type of research, but using the term *tutor* in this context seems misguided per Raines's (1994) definition of tutor.

Another different use of tutor and tutoring in the literature comes in the form of drop-in tutoring centers that are staffed by tutors that can answer questions students have. Cooper (2010) investigated the effect of the Tutoring Center at Western Washington University. The Tutoring Center was a study area where tutors walked around and circulated amongst the students to help answer any questions they had (E. Cooper, 2010). In their specific case, the tutors tended to be juniors or seniors that had done well in the courses they tutored for and were required to complete a certified tutor training course (E. Cooper, 2010). The results of the study focused solely on the amount of times freshman visited the Tutoring Center in order to link that to academic success and retention at the college. Nothing was done to investigate what happened in the Tutoring Center, how often the students asked questions, or the activities of the tutors. From my own experience as a tutor in a chemistry tutoring center, I can say that it is likely that the tutors spent between 1-5 minutes with each student as they answered their question. The questions varied as many different levels of students could be present at any given time in the tutoring center. This type of tutoring has similarities to some tasks that in-class tutors perform except without the structure of the course to constrain the amount of time spent with any individual student or the variety of students and courses present.

The final common usage of tutor in the literature deals with one-on-one tutoring situations. These tutoring contexts consist of a tutor and tutee dyad working together, usually for longer periods of time than would happen with drop-in tutoring or in-class tutoring. In a study by Lu et al. (2007) on expert versus non-expert tutoring, the study context dealt with one-on-one tutoring with the goal to understand the best tutors in order to improve ITS. The authors analyzed tutoring moves and the orders in which they appeared and the tutee moves that initiated those tutor moves in order to hopefully optimize ITS (Lu et al., 2007). One of the strange side-effects of this sort of study is that while its explicit purpose is for computer programs, it still provides insight into how human tutors perform. In one of the few studies in a STEM context, VanLehn et al. (2003) attempted to understand why tutoring only sometimes leads to learning. Their measure of this was a pretest, tutoring intervention, and posttest with the tutoring sessions lasting up to three to four hours (VanLehn et al., 2003). They found that the aspect most commonly related to a gain between pre and posttests was when students reached an impasse during the tutoring session, a moment where the student recognized that there was something they didn't understand (VanLehn et al., 2003). However, the posttest consisted of questions that were similar to the pretest in ways that

calls to mind a transfer study, and while transfer and learning are related, it would seem that a more delayed posttest might allow for a better assessment of learning. In fact, the researchers even mention that one of their post-test problems required further transfer than they had intended showing that the other problems were therefore near transfer (VanLehn et al., 2003).

While it is logical to conclude that there is a large amount of transferable skills between all these different tutoring contexts, it is important to know that they are in fact different. Work done in one context can certainly influence other contexts, but work done to understand a tutor in a classroom does not necessarily mean that work can be productive for understanding tutoring in a one-on-one situation. Thus, it is necessary to study all the contexts; however, not all the contexts are tutoring as I will be conceptualizing it. For example, a person assisting in a classroom has more in common with a teaching assistant or drop-in tutoring center tutor than with a one-on-one tutor as the time spent with any one student or group of students is likely to be much more limited. Similarly, there will always be a difference between anything that takes place inside a classroom or lecture hall compared to informal environments, thus necessitating a distinction between inclass assistants and drop-in tutoring center or one-on-one tutors. While computer programs are potentially the wave of the future and work done to improve those programs often involves studying human tutors in one-on-one interactions, a computer program or app on a student's phone are not the same thing as a human tutor. Being a tutor requires one to assess and react to a tutee and while programs are becoming more capable of that as time goes on, I feel we are a long way from truly tailored learning from any program.

2.2 Lack of Literature on Chemistry Tutoring

A search through the literature on *chemistry tutor* returns mostly reviews and studies of computer programs or research on in-class assistants, with very little to be said about tutoring centers or one-on-one tutoring. In the last year in the Journal of Chemistry Education, a search for the term *tutor* returns 43 items. When the search is narrowed from *tutor* being anywhere in the article to being present in the abstract, only 5 items are returned by the search. The majority that are filtered out by this refinement include the word *tutorial* somewhere in their text. Of the 5 articles that contain *tutor* in the abstract, two of the articles deal with tutorials (Hubbard et al., 2019; Le & Morra, 2019), one deals with a tutor program (Rathod et al., 2019), and two deal with human tutors (Clary-Lemon et al., 2019; Graham et al., 2019). Of the two that deal with human

tutors, one deals specifically with writing tutors (Clary-Lemon et al., 2019) while the other deals with students learning metacognitive skills from tutors who taught structured weekly classes on the topic (Graham et al., 2019). A search in one journal is not meant to be proof that studies do not exist but merely to serve as an example of their comparative rarity. The fact that none of these articles deals with one-on-one chemistry tutoring nor tutoring centers points to a lack of an on-going research conversation about these topics.

It has been stated that there is a lack of tutoring research in STEM (Agne & Muller, 2019; Velasco & Stains, 2015) as many studies done on tutoring are instead in the context of reading or writing (Al Chibani, 2014; Clary-Lemon et al., 2019; Raines, 1994). Studies within STEM tend to be in mathematics and focus on procedural problem solving (Chae et al., 2005) and it is believed that tutoring in a conceptual domain would require unique methods (Herppich et al., 2016). Chemistry has both procedural problem solving as well as difficult conceptual work making it a unique context for studies of tutoring. There is also a lack of studies of tutoring in higher education as the majority of studies take place in a K-12 environment (Velasco & Stains, 2015). Even amongst studies in STEM and higher education, there are studies that are merely incidentally about tutoring can accomplish that differently than classroom instruction. For example, while Manneh et al. (2018) looked at chemistry tutors helping tutees learning about oxidation as opposed to how tutors could facilitate that process. The study could have been done entirely without tutors and been more or less identical.

The general lack of literature dealing with chemistry tutoring shows that there is a large gap in the literature here to be addressed. Tutoring varies between topics and it is useful to study tutoring many contexts. Additionally, the variety of problem types present in chemistry presents a unique context for studies about tutoring.

2.3 Quantitative and Qualitative Research

Much of the research done on tutoring has been of a quantitative nature as the researchers focus on proving the benefits of tutoring (Bloom, 1984; Cade et al., 2008; Derry & Potts, 1998; VanLehn, 2011). This has been important work as it has cemented that tutoring is an effective way to help students. While VanLehn (2011) claims that ITS is catching up to human tutoring, it is still

clear that human tutoring is more effective. However, one thing that is mentioned in the literature is that while it is clear that human tutoring *is* effective, it is not entirely clear *why* it is so effective. As Siler and VanLehn (2015) state on page 344, "despite considerable research, it is still not entirely clear why tutoring is so effective." There have been many attempts to solve this riddle, including by Siler and VanLehn (2015) when they investigated whether tutors were actively microadapting to their tutees. In an earlier study, VanLehn at al. (2003) tried to answer why only some events caused learning during a tutoring session. Fukaya and Uesaka (2018) attempted to ascertain whether tutors would spontaneously use knowledge in tutoring scenarios. All of these attempts to answer the *why* tutoring is effective question functioned similarly in that they proposed a hypothesis, designed a study to answer it in a yes or no fashion, and at the conclusion of their study seemed no closer to answering that *why* question. These all rely on quantitative methods. While a quantitative method is useful for addressing these hypotheses, a qualitative study would be more likely to find the answer to a question like why tutoring does the things it does instead of employing something akin to guessing and checking. That is not to say that there exists no qualitative research or that these quantitative studies are not basing their hypotheses upon sound theoretical grounds, but that perhaps there needs to be more qualitative work done in the field.

Most research done on tutoring has been focused on outcomes and implementation, things that lend themselves to quantitative methods (Roscoe & Chi, 2007). In fact many studies, most specifically in the ITS literature, aim to find what feels like a set algorithm of how to tutor. It is treated as some sort of one size fits all type of problem when no two people are identical and thus require different things from a tutoring situation. Graesser et al. (2013) state that future research should set about creating a set of standards against which it is possible to judge a tutor. They argue that there should be a universal set of tutoring mechanisms and strategies so that it will be possible to evaluate the quality of a tutor (Graesser et al., 2013). This is more evidence of the prevalent one-size-fits-all mindset which reeks of policies like No Child Left Behind that try to standardize teaching and learning (Cochran-Smith & Lytle, 2006). In the same Graesser et al. (2013) article, the authors state that evidence for tutoring has accumulated from both correlational studies as well as true experiments, but request that more work is done with true experiments in order to advance the field. This article was from the Handbook of Research on Learning and Instruction (2013), showing that at least in some sectors of the literature, there is a strong bias towards quantitative over qualitative methods. However, as Roscoe & Chi (2007) write, the field needs to collect more

process data as they put it. Process data does not necessarily mean qualitative data but it is specifically data that relates to the *how* of tutoring as opposed to just the outcomes of tutoring. While it could still be quantitative in nature, looking at the process of tutoring, not just comparing beginning and ending states, fits nicely into the wheelhouse of qualitative methods.

Research that is less concerned with the outcomes of tutoring is much more likely to use qualitative methods. Methodologies vary from study to study ranging from discourse analysis (Agne & Muller, 2019) to autoethnography (Gardner & Lane, 2010; Paukova et al., 2019). The existing research on the tutor/tutee relationship and relational identities is consistently qualitative in nature. Applying discourse analysis, Agne and Muller (2019) examined the ways that discourse shaped the identities of the tutor and tutee in STEM tutoring, and how the tutor/tutee dynamic was co-created through conversation. They found that tutoring does more than pass on knowledge, it creates a relationship between the tutor and tutee as well as serving as a way of integrating the tutee into the STEM community through socialization (Agne & Muller, 2019). Gardner and Lane (2010) used autoethnography to explore the personal tutor/tutee relationship that they built through three years of working together. Since the role of personal tutor encompassed more than help with course content and extended into moral support, the relationship that developed was multifaceted. The co-creators felt that the use of autoethnography allowed not only for deeper introspection on both of their accounts but to also connect their story to a wider perspective, which in their case was nursing education (Gardner & Lane, 2010).

However, other aspects of tutoring would benefit from qualitative methods in order to explore the tutoring landscape more thoroughly. In their study of an English peer tutoring program, Mynard and Almarzouqi (2006) used interviews with tutors and tutees in order to understand the strengths of the tutoring program as well as its weaknesses which were then used to fine tune the program for future academic years. Quantitative methods could establish that the tutoring was not as productive as the department had hoped, for example, but it is unlikely that pre/post-tests could have uncovered information useful for making improvements to the program. The general lack of qualitative research in tutoring leaves a gap in the literature that this study can help fill.

2.4 Tutoring Moves and Modes

The importance of language to learning cannot be overstated (Markic & Childs, 2016; Taber, 2015) and that importance extends into tutoring scenarios as well (Lu et al., 2007). One-

on-one tutoring is a collaborative co-construction of meaning between tutor and tutee performed through the use of language and dialogue (Fox, 1993). Within the literature, the basic tactics and catalogue of types of things to say have been called tutoring moves. Tutoring moves are usually seen as having a small grain size and relate to individual utterances or small strategies (Cade et al., 2008). Essentially, this type of research concerns itself with "what the tutor says and when they say it" (Chi et al., 2001, p. 474).

There have been many articles looking at what tutors say and the frequency of moves in a tutoring dialogue. As a representative example, in a study comparing tutoring moves of expert and non-expert tutors, Lu et al. (2007) identified four main categories of tutor moves: reaction, initiative, support, and conversation. The authors further subdivide their first two categories. Under reaction there was answering, evaluating, and summarizing; under initiative there was prompting, diagnosing, instructing, and demonstrating (Lu et al., 2007). Unlike a majority of tutoring literature, the authors also categorized tutee moves and created six categories: explanations, questioning, reflecting, reaction, completion, and conversation (Lu et al., 2007). It was found that expert tutors use the summarize, demonstrate, and support moves more commonly than the less experienced tutors (Lu et al., 2007).

There are some researchers that feel as though looking at tutoring at the fine-grained level of tutoring moves is too narrow of a view. In an attempt to zoom out to larger instances of tutorial dialogue, Cade et al. (2008) looked at sequences of tutoring moves which they termed tutoring modes. The authors identified a total of eight mutually exclusive tutoring modes; five of the modes were directly related to learning while three of the modes were not. The three modes not directly related to learning were introduction, conclusion, and off topic (Cade et al., 2008). The five modes of most interest as they related to learning were lecture, highlighting, modeling, scaffolding, and fading (Cade et al., 2008). There is some overlap between the tutoring modes identified by Cade et al. (2008) and the tutoring moves identified by Lu et al. (2007). It is not surprising that there is overlap as it is likely that whether looked at as a whole or as a unit, tutoring still consists of tutoring moves. However, it is not clear how these different ways of looking at tutoring may encompass each other or not. For example, instructing (Lu et al., 2007) and off-topic (Cade et al., 2008) are likely covering the same areas. However, it is not easy to pick tutoring moves that fit under highlighting for example. Despite this, both tutoring moves and tutoring modes can co-exist and

work could, and perhaps should, be done to reconcile the micro and macro lenses that these theories provide.

Multiple theories to describe tutoring exist which describe a sequence of tutoring moves/modes or dialogue actions. One theory consists of three tutoring moves/modes that starts with modeling, moves into scaffolding, and ends with fading (Collins et al., 1989; Rogoff & Gardner, 1984). Within the modeling phase, the tutor shows the tutee how to solve a problem. Then comes the scaffolding phase when the tutee works through the same or a similar problem while the tutor provides assistance and guidance. Finally, in the fading phase, the tutor fades to the background and allows the tutee to work on their own. Cade et al. (2008) did not find this pattern present in their analysis of tutoring modes, finding instead that there was a cyclical relationship between lecturing and scaffolding, which were the most common modes present in their study. The modeling/scaffolding/fading model still provides a useful way to conceptualize tutoring but does not appear to be as present in real-world tutoring exactly as it is theorized.

Another theory to describe the process of tutoring is through a dialogue frame (Graesser, 1993; Graesser & Person, 1994; Person et al., 1995). This dialogue frame consists of 5 steps which occur in the following sequence: step 1 - tutor asks a question; step 2 - student answers question; step 3 - tutor gives feedback on quality of answer; step 4 - tutor and tutee collaboratively work together to improve the answer; step 5 - tutor assesses tutee's understanding of the concept. It is the final steps, steps four and five, that make tutoring different from teaching as the collaborative effort of the tutor and tutee to construct meaning is unique to this setting (Graesser et al., 1995; Roscoe & Chi, 2007).

In a study that builds a bridge between the literature on tutoring moves and the literature on relationships, Agne and Muller (2019) used discourse analysis to see what tutoring move analogs contribute to defining relational identities. The studied focused on how these identities are negotiated during a tutoring session and how what a tutor says helps form these relationships. One way that relational identities were negotiated was through encouragement talk, which has been found to be important in both mentor/mentee and teacher/student relationships (Agne & Muller, 2019). The next discourse strategy found was sensemaking checks which act as more than just making sure the tutee understands a particular problem, but acts as a way to allow for open communication, something which is important to building and maintaining a relationship (Agne & Muller, 2019). The final strategy was metadisciplinary talk (i.e., talk about the subject or

problem that went beyond just how to solve a problem) (Agne & Muller, 2019). This sort of talk was seen as a way to bring a tutee more into the specific disciplinary community which can be part of what tutoring in a subject can accomplish (Agne & Muller, 2019). Finally, by paying attention to the sort of discourse that exists during a tutoring session, it can help provide understanding of the sort of relationship the tutor and tutee desire as well as contribute to what makes tutoring productive (Agne & Muller, 2019). Agne and Muller (2019) contend that not only is the tutor/tutee relationship and relational identities understudied and unclear in a STEM context, but most importantly, worth examining in closer detail.

Ultimately, there are several different ways to conceptualize that activities that take place during a tutoring session. Whether viewed as moves, modes, or a dialogue frame, tutoring involves the interaction between tutor and tutee. More work should be done to reconcile different theories concerning the interactions between tutor and tutee to allow for easier discussion amongst researchers as to what occurs during tutoring. Some of the moves and modes are easily comparable, ultimately it requires the reader to recognize similarities present in the descriptions that different theories use to reconcile the different theories. This is not a call for a unified theory of tutoring but instead work to be done to make the different theories more compatible and comparable to each other.

2.5 The Online Learning Environment and COVID-19

Despite chemistry tutoring being the focus of this research, the context in which that tutoring takes place is extremely important. There are many things that contribute to the context of any given study, including the location and type of university, but those rarely require their own literature review. With nearly all of higher education being forced to venture into an online learning environment in March of 2020 due to the COVID-19 pandemic (Marinoni et al., 2020), online learning and the effects of the pandemic on all aspects of higher education deserves discussion.

In addition to the various uses of in-class tutors as previously described, chemistry courses employ a wide variety of strategies to maximize social interactions and the learning that comes from them (Jung et al., 2002; Youmans, 2020), including Peer-Led Team Learning (Lewis, 2011) and Process-Oriented Guided-Inquiry Learning (Chase et al., 2013). The pandemic made these strategies much harder to implement as courses moved online and the face-to-face interactions these strategies depend on became virtually impossible. The vast majority of courses were designed with face-to-face in mind and the shift to an online learning environment was thus not without struggle (Youmans, 2020). Effective online courses need to be specifically designed, just like in-person courses need to be specifically designed, and the switch presented many unanticipated challenges (Youmans, 2020). Online interactions can occur either synchronously or asynchronously, where people interact with each other live or at different times respectively. An example of a synchronous environment would be a live-stream of a lecture or group chat through an app, while an example of an asynchronous environment would be a recorded lecture viewable at any time or email. Both synchronous and asynchronous interactions can be beneficial to students and each have a role to fill in an online course (Jung et al., 2002).

The pandemic did not only disrupt students' academic lives, but also their personal, familial, and professional lives. The closure of universities forced many students to move out of on-campus housing and return home (Neuwirth et al., 2021; Youmans, 2020). This change in environment created myriad challenges for students as they may have extra responsibilities at home, including taking care of younger siblings or relatives at high risk for COVID (Neuwirth et al., 2021; K. N. White et al., 2020), or working extra hours at an essential job to make up for financial hardships caused by loss of work of other family members (Daniel, 2020; Irawan et al., 2020; K. N. White et al., 2020). Students from families of lower socioeconomic standings reported more anxiety than students from families with more stable financial situations (Goodman, 2020; Irawan et al., 2020). The pandemic took students away from the support system of friends and peers they relied upon and placed them in an isolated social setting with no idea how long they may remain isolated. Students faced many mental health challenges caused by the pandemic, with one poll finding that more than half of the polled population felt the pandemic negatively affected their mental health (KFF Health Tracking Poll - Late April 2020, 2020) and another poll finding that almost 70% of respondents found the pandemic as source of stress (Raj & Fatima, 2020). Not only did some students battle depression and anxiety, but the pandemic could even be classified as traumatic for many (Youmans, 2020).

Being forced to work from home while switching to an all online curriculum created a fragile situation for some students. University campuses offer a wealth of technological advantages from computers in libraries or tech centers that students can use to access high-speed wireless internet that students may not have access to at home. Chávez-Miyauchi et al. (2021) found that the most common difficulties that students reported were related to technological issues at home

during the pandemic. Among the many issues reported, failure of internet service and problems with the programs used for synchronous interactions were the most pressing (Chávez-Miyauchi et al., 2021). Even students with sufficient internet connection and no issues with programs can still face trouble as the family may share a small number of devices, and with parents similarly forced to work from home, available computer time may be extremely limited (Youmans, 2020). Additionally, students in a crowded family home may not have access to a private or quiet place to watch lectures or study (Neuwirth et al., 2021). All of these issues, from internet connection to availability of computers and privacy are exacerbated for students of lower socioeconomic standings, compounding already present systemic inequity (Daniel, 2020; Neuwirth et al., 2021).

Ultimately, COVID-19 caused many changes to our educational systems, most notable in the forced shift to the online learning environment. While this change impacted all students, it affected some students more than others. Students of lower socioeconomic status were more likely to have difficulty accessing the online content while also being more likely to have more responsibilities placed upon them due to their family situations. The pandemic both exacerbated equity issues already present while creating new ones.

CHAPTER 3. THIS STUDY: UNDERSTANDING TUTORING MOTIVATIONS

3.1 Philosophical Orientation

The goal of this research is not to present an objective representation of the chemistry, tutoring, or the global pandemic but instead to present the way that these contexts influenced how people felt. The focus is on their experiences, not on a concrete reality. Each person experiences their own reality in their own unique way influenced by uncountable unique factors (Furlong & Marsh, 2010). These concerns over experiences and personal realities extends not just to the participants of this research but to me as well. Much as the data collected represents the participants' experiences not the reality itself, the results thus cannot represent a reality of the data but merely my biased interpretation of it. My own experiences as a tutor and the knowledge I have built through reviewing the literature on tutoring cannot help but color my perspectives. Instead of attempting objectivity by minimizing myself, I will allow my knowledge and experiences to shape me into the instrument of analysis consistent with doing qualitative research.

3.1.1 Theoretical Perspective: Self-Determination Theory

At the heart of self-determination theory (SDT) are psychological needs (Ryan & Deci, 2017). While the term *need* has certain connotations in everyday language (for example, I *need* to see that new Spider-man movie before someone online spoils it), when it comes to needs in SDT, there is a much more specific and narrow definition. A psychological need is something that is essential for a person's adjustment, integrity, and growth (Ryan, 1995). Within this framework, not only are needs necessary for well-being, but the absence or frustration of these needs can lead to ill-being (Vansteenkiste et al., 2020). In fact, the frustration of a need manifests a stronger reaction and more threatening experience than just the mere absence of a need (Vansteenkiste et al., 2020). According to SDT there are three basic psychological needs: *autonomy, competence*, and *relatedness* (Ryan, 1995; Ryan & Deci, 2017, 2020).

Autonomy refers to experiences of initiative and ownership of one's actions. When satisfied, people will feel a sense of integrity and that their actions, thoughts, and feelings are their own and authentic (Vansteenkiste et al., 2020). When frustrated, people feel pressure, conflict, and like

decisions are being made for them (Vansteenkiste et al., 2020). In the context of students, a student who is autonomous will devote time and energy to their work of their own volition (Niemiec & Ryan, 2009). This feeling can be supported when people have interest in an experience or see value in it (Ryan & Deci, 2020).

Competence refers to experiences of mastery and growth. People will have this need satisfied when they engage in activities in which they feel effective and in which they can use or grow skills or expertise (Vansteenkiste et al., 2020). When this need is frustrated, people can feel ineffective, helpless, or even like they are a failure (Vansteenkiste et al., 2020). For students, this need can be met when they feel able to meet and concur the challenge of their work (Niemiec & Ryan, 2009). This feeling can be supported by well-structured environments that scaffold growth and provide challenge and positive feedback (Ryan & Deci, 2020).

Relatedness refers to experiences of bonding with other people. People will have this need met when they feel a sense of belonging or connection, when they feel significant to others and that others care about them (Vansteenkiste et al., 2020). When this need is frustrated, people can feel isolated, excluded, and lonely (Vansteenkiste et al., 2020). For students, this need is often associated with feeling like their professor or TA respects and values them and that their peers welcome them into their group (Niemiec & Ryan, 2009). This feeling can be supported by showing respect and care when interacting with other people (Ryan & Deci, 2020).

Under the umbrella of SDT, there is consideration given to the difference between intrinsic and extrinsic motivations. Activities that have an intrinsic motivation are done because people find them inherently interesting or enjoyable (Ryan & Deci, 2000). People engage in these activities due to their own curiosity and desire and receive joy and satisfaction from that engagement (Ryan & Deci, 2020). If people have their need for both autonomy and competence satisfied they will be able to sustain an intrinsic motivation (Niemiec & Ryan, 2009). For students, intrinsic motivation has been shown to predict student engagement which in turn has been shown to predict higher grade point averages (Froiland & Worrell, 2016). Even though SDT considers intrinsic motivations to be a complete whole unto itself, extrinsic motivations are not a homogenous group and it is important to look at them as a spectrum based upon their degree of internalization of the motivation (Niemiec & Ryan, 2009; Ryan & Deci, 2020). Extrinsic motivations are broken down into four different categories with an increasing amount of internal motivation: *external regulation*, *introjected regulation*, *identified regulation*, and *integrated regulation*. *External regulation* refers to behaviors that are entirely externally driven and is characterized by outer rewards or punishments (Ryan & Deci, 2020). This type of motivation typically makes a person feel controlled and not autonomous. Additionally, once the outside reward or punishment is removed, the behavior is not likely to continue (Niemiec & Ryan, 2009). This is an extremely common motivation in school where students will study for an exam in order to get a good grade or to avoid a bad grade. The next step on the spectrum is *introjected regulation* where behaviors are regulated by internal rewards or punishment (Ryan & Deci, 2020). Examples of internal rewards are self-esteem or pride while internal punishments are shame or guilt. This is an example of ego involvement where the ego drives the desire to feel pride or avoid shame (Niemiec et al., 2008). Both external regulation and introjected regulation are experienced as relatively controlling and thus do not satisfy the need for autonomy.

Identified regulation refers to behaviors that are performed because there is value and importance to the actions (Ryan & Deci, 2020). For a student experiencing identified regulation, instead of studying to get a good grade or to feel pride, they will study for an exam because they feel it has important relevance to their future career (Niemiec & Ryan, 2009). The final form of extrinsic motivation is *integrated regulation* where the process of internalization is complete and not only is there value to be found in a behavior but the behavior also aligns with other aspects of the self (Ryan & Deci, 2020). Here, a student might study not just because it will help their future career but because that career will help others, aligning with the student's values and interests (Niemiec & Ryan, 2009). Both identified regulation and integrated regulation are experienced as relatively autonomous.

The major difference between relatively autonomous extrinsic motivations and intrinsic motivations is that behaviors linked with intrinsic motivations are done because they are enjoyable, engaging, or fun while the behaviors linked with autonomous extrinsic motivations are done because they are seen as valuable and worthwhile even if they are not enjoyable (Ryan & Deci, 2020). The progression from external regulation to integrated regulation is called internalization which reflects how much a person has assimilated ambient values or practices (Vansteenkiste et al., 2020). In order for a task or behavior to be internalized, a person must value the task or outcome and experience ownership of it (Vansteenkiste et al., 2018). A fully internalized motivation will satisfy all three of the basic needs, providing a sense of effectiveness, volition, and connection (Vansteenkiste et al., 2020). While the need for competence and autonomy has long been

associated with internalization, it is also necessary to include relatedness as experiencing a strong bond and connection with others engaged in a task or encouraging a task supports internalization of motivation (Milyavskaya et al., 2014).

One potentially controversial aspect to SDT is its claim to universality, specifically when it comes to the need for autonomy (Markus & Kitayama, 2003). Some would argue that a need for autonomy is not present in a collectivist culture and that autonomy is a by-product of an individualistic culture. This argument is partially due to a misunderstanding about what SDT means by autonomy (Vansteenkiste et al., 2005). Within SDT, autonomy does not refer to acting independently or making choices independently but to a feeling of volition and authenticity to one's actions and thoughts (Vansteenkiste et al., 2020). Thus, it is entirely possible to be part of a collectivist culture or hold collectivist values and still experience autonomy. An important aspect of autonomy support in education is when the learner has their internal frame of reference respected (Ryan & Deci, 2020). A teacher that wants to support the autonomy of their students must thus be able to work with people from diverse backgrounds and value systems and respect those value systems (Ryan & Deci, 2020). As Ryan & Deci (2020, p. 5) state, "autonomy support entails, by definition, respecting and attempting to appreciate the perspective of, and unique challenges faced by, each learner." Autonomy support is thus seen as an important aspect of making education inclusive to all learners.

3.1.2 Theoretical Definitions

For this study, I have operationalized the following terms, drawing from Graesser and Person's 5-step dialogue framework (Graesser, 1993; Graesser & Person, 1994; Person et al., 1995): tutor, tutee, student, and tutoring. As has been established, a tutor can be many different things in different situations. It is a term that refers to several disparate roles and identities that people can inhabit and perform. In this study, *tutor* refers to a person helping another person, their tutee, by providing one-on-one learning assistance outside of a classroom environment. Within this context, the role of the tutor can expand or contract based on the particular needs of the tutee and the relationship between tutor and tutee, but this is explicitly different than a personal tutor as they are known in the UK, where a personal tutor is an academic staff member (Yale, 2017). The tutor in this study context may or may not provide the sort of mentorship that a personal tutor supplies, but it is not a necessary condition for being a tutor. Tutor/tutee pair together in the same way that

teacher/student pair together, thus the person the tutor is working with is called their *tutee* as opposed to their student to retain the difference between tutor and teacher. The usage of *student* is used to refer to people participating in the same course as the tutees in this study who are not, to the best of my knowledge, seeking or taking part in tutoring. *Tutoring* refers to the actions and interactions of the tutor and tutee, in general confined to the specific time and place of the tutoring session. Interactions between the tutor and tutee outside of the specific time and place of the tutoring session could, and likely would, contribute to the tutor/tutee relationship, but this would not be considered tutoring unless the interactions relate to passing on knowledge, helping with academic issues, or mentoring.

3.1.3 Research Goal

The goal of this research study is to understand the factors that lead to or inspire a student to seek out a tutor. This goal is focused on characterizing and understanding the motivations and desires of students that feel the need for informal learning opportunities.

3.2 Methodology

This study adopts a case study methodology. Cases can be viewed as either empirical units or theoretical constructs; under each view, cases can be either viewed as specific or general (Ragin, 1992). Within this study, the case is online chemistry courses and how tutees experience said courses. The case is also specific as it relates to tutoring and these online chemistry courses at this specific point in time, the first full academic year in the pandemic. In this sense, as per Ragin (1992), the case is made, as opposed to found; the case is also not object nor convention. When a case is made, it is "a specific theoretical construct imposed on the empirical evidence" (Schwandt & Gates, 2018, p. 601). While cases can be viewed as isolated and cut-off from surroundings, a more recent view of cases is that they are in fact complex systems that are both holistic and comprised of complex constituent parts; they are fuzzy realities that intersect with their borders (Schwandt & Gates, 2018). The holistic view of cases is still important though as it acts to oppose the radically analytical methods common in quantitative studies (Ragin, 2014).

There are many views and beliefs about what a case study is and how to conduct one, but in their chapter in the SAGE Handbook of Qualitative Research, Schwandt and Gates (2018) list some commonalities amongst case studies of a social phenomenon, which I contend tutoring and a tutor/tutee relationship would fall under. Case studies should proceed "by monitoring the phenomenon during a certain period," be "carried out within the boundaries of one social system," and occur "in the case's natural context" (Schwandt & Gates, 2018, p. 603). Schwandt and Gates (2018) suggest that within a case study, the researcher should start with a broad research question or goal, and only formulate more precise research questions after exploring the data.

There are several different approaches to case study designs, and while these designs may be distinct, they are not necessarily mutually exclusive (Schwandt & Gates, 2018). Thus, some studies will fall in between different designs or may be a blending of two or more commonly recognized designs. This research as presented falls only into one design. This research is a descriptive case study (Schwandt & Gates, 2018; Yin, 2017). The main goal of this research is aimed at understanding what students feel about the chemistry course, the online context, and the learning that they feel they are not getting. The goal is to describe the experiences and motivations of these students as they pursue informal learning opportunities, specifically tutoring.

3.2.1 Participants

Participants were recruited over the span of two semester in the academic year 2020-2021. Participants were recruited as approved by the Purdue University Human Research Protection Program as IRB-2020-1031. The participant designations, their semester, and the course they were recruited from can be found summarized in Table 3.1. While the tutees came from two different chemistry courses, both were courses for non-chemistry majors. The tutor that participated was a tutor for chemistry 115 and they worked with both Tutee 1 and Tutee 2, in Fall 2020 and Spring 2021 respectively. I was the tutor for Tutee 3, Tutee 4, and Tutee 5 but their data was confined to semi-structured interviews.

Participant Designation	Chemistry Course	Semester
Tutee 1	CHM 115	Fall 2020
Tutee 2	CHM 115	Spring 2021
Tutee 3	CHM 111	Spring 2021
Tutee 4	CHM 111	Spring 2021
Tutee 5	CHM 111	Spring 2021
Tutor	CHM 115	Fall 2020 & Spring 2021

Table 3.1 List of participants along with their course and semester.

3.2.2 Research Questions

- 1. What aspects of the chemistry course and content motivate tutees to seek out tutoring?
- 2. What aspects of the online learning environment created challenges that led tutees to seek out tutoring?
- 3. What are the tutees' hopes and expectations of what tutoring can provide for them?

3.2.3 Methods

The goal of this research was accomplished using semistructured interviews as the prime source of data. Semistructured interviews act as a middle-ground between restrictive survey-like interviews in which there is no room to pursue unexpected threads of conversation and entirely freeform interviews in which the interviewer may lose control of the direction of the interview (Brinkman, 2018). A semistructured interview is used "with the purpose of obtaining descriptions of the life world of the interviewee in order to interpret the meaning of the described phenomena" (Brinkmann & Kvale, 2014, p. 6). Here, the term *lifeworld* is also sometimes called *lived experiences* and refers to the shared, subjectively experienced world in which humans experience phenomena (Brinkman, 2018). Similarly, it is important to understand what Brinkman and Kvale are referring to when they say "interpret the meaning." Interviewers must be open to interpreting what is said in an interview in multiple ways as lifeworld phenomena "are rarely transparent" and "sometimes even contradictory" (Brinkman, 2018, pp. 1004–1005). Thus, interviews can supply rich and messy data allowing for many interpretations and care must be taken to not impose preconceived notions upon them.

3.2.4 Analysis

The semi-structured interviews were analyzed through a combination of open coding and a general inductive analysis (Thomas, 2006). This process was iterative and resulted from repeated exposure to the interview data. Codes, categories, and general themes were created and used to code the data. As opposed to strictly starting in either the macro sense (general themes) or the micro sense (codes), the data was treated in a manner that seemed appropriate at the time of initial analysis. This meant that while some instances were directly coded as *codes*, some instead were coded first into a category or a general theme before a *code* was decided upon. As this process was iterative, codes, categories, and themes continually shifted as the data was reanalyzed. After several iterations, all codes fell into categories and all categories fit general themes and thus coding was deemed complete (Thomas, 2006).

The next step was to use the codes to answer the research questions. Each research question had certain codes that pertained to it, and those relevant codes were then collected and the quotes they contained were used as evidence to back up the answers to the research questions. The final step of analysis was to take those answers and filter them through SDT in order to arrive at a deeper understanding of those answers and thus became the findings. This step allowed for answers to the research question to be understood in terms of the three needs of SDT. By understanding how the tutees felt and what needs were left unsatisfied it is then possible to turn the answers to the research questions into findings. The findings are the sum total of all the analysis steps carried out. The findings are thus in a state to be placed into a larger context and conversion for comparison with other literature. Figure 3.1 portrays this process in a visual medium. The full definitions of codes and examples can be found in the code book section in Appendix A, including codes not used in the analysis of this data that were none the less generated in this process.



Figure 3.1 The analysis method. The left side of the figure depicts the data input from the interviews and then the iterative process of coding. The output of this process was the organized quotes. These quotes then fed across to the research questions where they provided the evidence to answer the research questions. These answers then filtered through the theory to arrive at the findings.

CHAPTER 4. RESULTS

4.1 Research Question 1

The first research question was: what aspects of the chemistry course and chemistry content motivate students to seek out tutoring? This research question looked at all aspects of the context of the course including the actual chemistry being learned within the course. While the online aspect of the course is a very large part of the context of the course, online concerns will be addressed in research question two. The major themes found were: tutees felt they lacked a relationship with either their professor, their TA, or both; tutees felt that the course moved very fast for the amount of content required; and tutees felt that the chemistry questions, specifically word problems, were overly complex in a way to trick and confuse them. The themes, relevant codes, and aspects of SDT are summarized in Table 4.1.

Table 4.1. Summary of relevant information for Research Question 1.

Research Question: What aspects of the chemistry course and content motivate students					
to seek out tutoring?					
Relevant codes: Chemistry (challenges), chemistry (college), lab, professors & TAs, and					
recitation					
Themes	Self-Determination Theory				
Lack of relationship with professor/TA	Relatedness				
Course speed and content amount	Competence				
Word problems	Competence & Relatedness				

4.1.1 Lack of Relationship with Professor/TA

Tutees cited a lack of relationship with their professor or their TA as a motivating factor in them seeking tutoring. The lack of a relationship can be viewed as not satisfying the need for relatedness as defined by SDT (Niemiec & Ryan, 2009). This was a frequent topic that was present across most of the participant interviews. The degree to which it was a problem varied from tutee to tutee where some had their need for relatedness merely not fulfilled while some had their need actively denied. Tutee 1 had issues in general with emails with both their professor and their TA, but also had what they viewed as a hostile interaction with their TA through email.

"I like so many times throughout these lectures. I have a question. And I'm like, 'Yeah, I could email them but who knows if they...' Like I've sent many professors

emails, and then I've sent my TA emails and he basically told me to f^{***} off like, um, so yeah, that was awesome." – Tutee 1

They would go on to elaborate on the interaction with their TA.

"I asked for help from that person's teaching recitation privately, and they said no. Like, how is that gonna make me want to even ask for help in the future? Like, I literally was like, 'I don't understand how to do this last question. Can you help me?' And he was like, 'No, I cannot.' And that's all he answered my email with." – Tutee 1

Tutee 1 felt as though they were cut off from their professor and their TA since email was the only real way to interact with them during the pandemic. They understood that having a relationship with someone with chemistry knowledge could prove useful and thus they decided upon tutoring:

"And like, that's why the tutoring. I was like, 'Yes, tutoring, sign me up' just because it was, like, nice to be able to talk to someone who knew what they're talking about and taking the class before and is like, 'Oh, yeah, this is what you're confused on. This is how I do it."" – Tutee 1

Both Tutee 2 and Tutee 3 had similar thoughts about their professor and TA. While neither had the same sort of actively negative interaction as Tutee 1 had with their TA, they both expressed a general sense of disconnection from their professor and TA. When asked whether they ever had a chance to talk with their TA, Tutee 3 replied:

"Um, I tried. I mean, you can ask questions throughout the class. But they're on like, a fast schedule, I guess. So like, you can't talk to them after class at all, after recitation I mean." – Tutee 3

The remoteness necessitated by the virtual-learning environment due to the ongoing pandemic was a large factor in the perceived lack of closeness with instructors.

"I could go to office hours and do that but I don't know my professors on a personal level because all of their videos are recorded and sent to Brightspace. Like, I've never talked to them before. That's just weird." – Tutee 2

Tutee 2 mentioned that the perceived lack of closeness with their instructors was a reason for them to search out other learning opportunities.

"If I had TA that I had a better relationship with it would... it might be worth it to search on YouTube for the video and then go to office hours for with my TA and talk things through." – Tutee 2

"I feel like finding that relationship with a TA is really slim given COVID and also majority of classes anymore online. So it's really hard to have a relationship like that with a TA when they've never seen your face." – Tutee 2
Tutee 2 felt that they lacked any sort of closeness with their instructors and thus did not feel as though they could reach out to them if they had questions. They specifically cited the lack of face-to-face interaction as part of the problem. Both Tutee 1 and Tutee 4 echoed similar sentiments about the lack of face-to-face interactions.

"I just miss the interaction and the personality aspect. That's why the videos also suck because you can't even see the professor, all you see is just their screens. I don't know what a single Professor looks like." – Tutee 1

"I would probably just say like, there's not a lot of I'd probably say a big part of it, is the lack of interactions with professors and TAs. So like, we have our lectures, we don't usually ask questions there in the middle of it. [...] Like, if I send them an email, of course, it kind of takes a while for a response. And two its email, so it's not going to be as in depth as I need it to be. Like for me, I'm a visual learner. So when someone's explaining something to me in emails, it's like, I see it, and I can't comprehend it." – Tutee 4

The forced online context of these quotes will be explored further in research question 2, but here it is important to note the relationship between online interactions, such as email, and tutees desire to have a connection with a tutor. The tutees feel that a tutor would be able to satisfy the need for relatedness that neither their professor nor their TA are able to fulfil.

4.1.2 Course Speed and Content Amount

Another aspect of the chemistry course that some tutees found to be problematic was the speed at which new topics were introduced as well as the overall amount of content that was required. Additionally, tutees felt that there was not enough connection made between topics covered or between lecture material and the experiments performed in the laboratory section of the course. This was not as common of a point made by the tutees but still came up in multiple interviews. The usage of the word *connection* here is not in reference to a connection between people and thus the issue here is not one of relatedness but of competence as defined by SDT (Niemiec & Ryan, 2009).

Tutee 2 felt that the course moved fast and that it expected people to enter the course with the requisite prior knowledge.

"Oh, Chem 115 is much more advanced obviously. What I learned in high school is covered in like the first week it felt like, and it was just kind of like assumed in Chem 115 of everything that we've learned there wasn't much review, even though

I feel like I haven't learned it for three, almost four years now. It's just, it was just assumed that we understood it all still." – Tutee 2

They went on to elaborate more on the speed of the course.

"And it's just every new lecture is a new topic. And I understand that's how it should be. It's just overwhelming sometimes. Because it just feels like I've been thrown into this and just new material just keeps coming at me every week and you're just still trying to learn what last week's material was." – Tutee 2

They go on to emphasize that the problem is not the concepts themselves, merely the amount that

they find overwhelming.

"I would say it's more the amount that I have to learn and the... I don't think the concepts are necessarily difficult, but I think it's hard to learn them because of, I don't understand the lectures very well." – Tutee 2

While Tutee 2 was referring to the overall speed of the course itself, Tutee 4 felt that the professor

went through problems themselves too quickly.

"I see that a lot in my chem professor, he'll bring up all these compounds and these names, just like out of thin air, or like, go through a problem super quick, super vague. And it's not just because he's being a jerk, and being like, 'you should know this.' It's just simply because he knows it so well. He works too fast for anyone to be on the same pace or to understand." – Tutee 4

Tutee 1 mentioned that not only was there a lot of information given all at once but that the labs

and lecture did not match concepts well making things harder than they would be otherwise.

"I feel like each unit of chemistry, you're given a lot of information all at once, obviously, it's college. And so when I get like, it's also the lab portions, the post lab aren't by unit that correlate with the unit you just learned, it's like two or three weeks back. So I have a hard time distinguishing what I just learned in lecture versus what I just learned in lab or was supposed to learn." – Tutee 1

Tutee 1 felt that not only did the post-lab questions not correlate well with the lecture material, but

they also felt they were disconnected from the labs themselves.

"Post labs literally just give me so much stress and anxiety every week, just because it's post lab, but they don't apply anything that's in the lab. [...] I have like, rarely, rarely seen a correlation to the lab. Because sometimes I understand the lab perfectly fine. Then I get to the post lab and I'm like, 'what were you trying to convey then if I understood understood the lab and this is what you want me to learn?"" – Tutee 1

All of this is related to tutees' need for competence. Tutees feel as though they do not have the time to master the concepts that are presented to them. When people do not have their need for competence satisfied they may feel helpless or like a failure (Vansteenkiste et al., 2020). While people may find their need for competence unfulfilled due not being challenged enough, it is clear that for these tutees that they feel unable to meet the challenges presented to them and thus desire the help of a tutor.

4.1.3 The Trouble with Word Problems

Tutees found that the phrasing of chemistry problems, not the chemistry content of the question, to be a source of stress. The difficulty of the questions created a scenario where tutees were not able to satisfy their need for competence leaving them feeling helpless and lost (Niemiec & Ryan, 2009). Unlike the previous topics where it was a common thread amongst the tutees interviewed, this concern was mainly voiced by Tutee 1, however, it was something they felt strongly about and thus deserves examination.

Tutee 1 began by simply pointing out that the word problems present a lot of information and that they are not sure where to focus their attention.

"I really have a hard time like looking at all these different numbers and words and like focusing them somewhere, and like trying to figure out what they're asking for based off what they give." – Tutee 1

They again reference the amount of information given with them problems and how that causes problems for them.

"I get so confused with all the different units and all the different equations and all the different just, like everything. I just it just all gets jumbled and like I can't pick out what even like unit would they were basing it off of because of how wordy they are and how like almost over specific they are or so or maybe even under it's so under specific that I'm just like, 'do you want do you want the mass? Do you want the volume? Do you want the structure?' Like it's hard for me to decipher what the word problem was getting at, I guess." – Tutee 1

During the interview, I wanted to understand more about what they meant by using the word "decipher." My question and their response follows.

"Interviewer: So anyway, do you feel like working with a tutor could sort of help... I really don't want to, like, put this idea into your head, but sort of like translate in a way?

Tutee 1: Yeah, that's a good way of putting it yeah. Like, decrypt how the professor, what the professors are wanting with the wordy, the wordy problems they give."

Despite suggesting "translate" as a way to understand their relationship to the word problems and the professors who write them, Tutee 1 used the word "decrypt" instead still echoing their earlier use of the word "decipher." While "translate" evokes moving from a foreign language to known language, both "decrypt" and "decipher" imply moving from a coded message to an understandable message. This implies purposeful obfuscation on the part of the question writer, a feeling that Tutee 1 went on to express plainly.

"I feel like they're trying to trick us up. And that's why I need help like, the puzzle like, 'this is what you're given, now, this is what they want.' [...] Like, when you go back to the puzzle analogy, like, I was almost thinking of it, like, someone just spilled out 1000 piece puzzle in front of me. And then if someone shows me what it's supposed to look like, then yeah, I could put a puzzle together. But if I don't know what the puzzle is supposed to look like, how am I ever supposed to put it together?" – Tutee 1

Tutee 1 is viewing word problems not just as a problem to be solved, but first as a puzzle to be pieced together before the problem solving can even begin. This extra layer of puzzle creates a situation where they feel helpless which leaves their need for competence unsatisfied (Niemiec & Ryan, 2009). They also believe that professors or problem writers create purposefully obtuse puzzles in order to trick students. There seems to be not just a lack of a positive relationship between Tutee 1 and their professor but Tutee 1 feels there is an adversarial relationship in a way. This adversarial relationship not only does not satisfy a need for connectedness but actively leaves that need unfulfilled. One of the ways that a satisfied relatedness need can manifest in a student/teacher relationship is through feeling that the teacher respects and cares for the student (Niemiec & Ryan, 2009) and Tutee 1 does not feel respected or cared for.

4.2 Research Question 2

The second research question was: what aspects of the online learning environment created challenges that led to students seeking out tutoring? While the first research question was concerned with the whole context of the chemistry course, this research question is completely focused on the online particulars. It was impossible to completely remove the effects of the online learning environment from the first research question however this research question deals with the more direct aspects of the online context. The major themes found were: tutees felt that they were forced to teach themselves the material; tutees felt disconnected from other people including,

professors, TAs, and the other students in their class; and lectures felt hard and labs felt useless. The research question, relevant codes, and the themes and their corresponding SDT need can be found summarized in Table 4.2.

Table 4.2. Summary of relevant information for Research Question 2.

Research Question: What aspects of the online learning environment created challenges	
that led to students seeking out tutoring?	
Relevant codes: Chemistry (college), lab, online (challenges) professors & TAs	
Themes	Self-Determination Theory
Forced to teach themselves	Competence & Autonomy
Disconnection from other people	Relatedness
Lectures are hard, labs aren't useful	Competence & Autonomy

4.2.1 Forced to Teach Themselves

A common feelings amongst tutees was that the online nature of the course left them feeling as if they had to teach themselves the material as opposed to learning it from interacting with the course. This can be seen as an issue of both competence and autonomy in accordance with SDT (Niemiec & Ryan, 2009). It is important to understand that in SDT, autonomy is not the same thing as independence as some believe (Vansteenkiste et al., 2005) but that autonomy refers to being in tune with and acting according to one's inner desires (Vansteenkiste et al., 2020). Thus, if tutees are feeling forced into the position of teaching themselves they are not having their need for autonomy satisfied. It is likewise an issue of competence as tutees do not feel capable of teaching themselves and do not feel as though they are learning the material as well as they would otherwise.

A couple of the tutees explicitly stated that they felt like they were teaching themselves in their chemistry course due to its online nature.

"It [the course being online] makes it 10 times harder because I feel like I'm just teaching it to myself." – Tutee 1

"Whereas chemistry is a lot, it's a lot more self-taught. And I think that's mainly because of the online component." – Tutee 2

Tutee 1 had a bad experience with chemistry in high school where they felt that their teacher was not very good and didn't explain anything. They felt that the only way they made it through the class was through their friends and through Khan Academy. "There's a lot of crying sophomore year, just because I would get so frustrated with it. I would either have to ask one of my friends in the class for help, to teach, almost reteach it to me more. Or I'd just have to like go on Khan Academy and have them... That's how I really got taught to be was Khan Academy." – Tutee 1

They went on to contrast their experience with their anatomy class they took before COVID with their online chemistry course to illustrate that the online aspect forced them back to their coping mechanisms from high school chemistry.

"Like when I had it for bio lab, like my anatomy class last year, I did well, because I could talk through the steps with my TAs and be like, 'listen, like, this makes sense. This doesn't. How do I get from A to B?" But now it's just like, get from A to B anyway you can, use the internet, because you have to like, I'm back to Khan Academy and Chegg, like, how is this any different from high school?" – Tutee 1

Tutee 2 similarly made a comparison to other classes to expand upon their feeling that their chemistry course was self-taught, but their courses were courses they were taking concurrently with their chemistry course.

"So I guess it'd be easier probably to compare it to my major specific class, which would be my Speech, Language, and Hearing science class. And it is in person, I have a lab for two hours or a two hour lecture, so to speak. And I can sit down and zone in, you know, and I can take notes the entire time, and I'm in sitting in person in class, I have a lot easier time understanding that class, whereas chemistry, I kind of look through the PowerPoint slides, figure out what concepts were learned; YouTube, Google, search them or whatever, trying to figure it out on my own. [...] Whereas chemistry is a lot, it's a lot more self-taught. And I think that's mainly because of the online component." – Tutee 2

Neither Tutee 1 nor Tutee 2 enjoy the self-taught aspect of their courses, it is not the way they would choose to learn. Tutee 1 is reminded of their traumatic time in high school chemistry and Tutee 2 feels that their other courses are more instructive and easier to understand. The self-teaching is something they feel forced to do, violating their need for autonomy.

While Tutee 4 did not explicitly mention self-teaching, they did say that they felt the online aspect of the course made the course require more effort.

"And you can see it's affecting the students, because our professors told us that our classes' test averages have been a lot lower than years before while they're in person. So I mean, there's definitely an effect, it's definitely harder to like to understand the material, you really have to put a lot of extra effort in." – Tutee 4

When reflecting upon the difficulties of using email to ask questions and the general inability to interact with professors and TAs due to the online nature of the course Tutee 4 felt required to do the work themselves.

"So it's just like, I don't know, it's just like you're missing a layer of help, or something that can really help you. And it's just kind of like, you're more on your own." – Tutee 4

While none of the tutees make explicit references to competence, it can be found the context of the study. All of the participants in this study felt the need for tutoring and were working with a tutor during the semester they took their online chemistry course. If the tutees were having their need for competence in the course met by their self-teaching methods it is unlikely they would have been motivated to seek out tutoring to begin with. Thus, the tutees needs for both autonomy and competence were left unsatisfied by their feeling that they were forced to teach themselves due to the online nature of the course.

4.2.2 Disconnection from Other People

Another frequent theme amongst the tutees interviewed was a sense of disconnection from other people, mainly focused upon professors/TAs and other students. Again, there is an unavoidable amount of overlap with the first research question as the lack of relationship with professors or TAs was a major theme there, the online aspect of which will be explored in greater depth here. There was also a sense of disconnection from other students and what the tutees felt that were missing out on by the social distancing enforced by the pandemic. This sense of disconnection can be understood through SDT as tutees found their need for relatedness to be unsatisfied which impacts their ability to learn and navigate a course (Niemiec & Ryan, 2009).

When asked how they felt about their chemistry course being online, Tutee 3 was not happy with it and recalled how they missed being able to work with other people like they did in their high school chemistry class.

"I think it's horrible. Just in general, any class being online, and especially chemistry. Just for comparison to high school, like, we would have whiteboards and you would talk to a table and you would like write it out, and practice stuff with your classmates too. So you have multiple minds working on one thing and you see things you wouldn't see." – Tutee 3

They did not specifically tie their dislike of chemistry being online to the lack of interaction with other students, but by transitioning directly from the one thought to the other, the connection between the two in the mind of Tutee 3 is inferable.

A couple other tutees reflected upon either how they missed interactions with other students, how interactions with other students were harder now, or how in general working with other students was helpful to them. Understanding the ways in which the tutees viewed working with other people as helpful can help illuminate the ways the online environment made that more difficult and how that would impede their learning.

Tutee 5 pointed to how they are able to understand a concept better after working with other people than just on their own.

"Um, when I can pull the knowledge from other people, like, if I'm struggling with a concept, it's a lot easier for me to pull the knowledge from other students that can explain it to me, and just kind of get that grasp working through all the problems with other people." – Tutee 5

When referring to a study group of other students they were a part of, Tutee 4 reflected on how hard it was to form a study group.

"It's hard to make connections and lectures, or recitation recitations. Because like, they're so limited, and you're not like, they encourage you not to work in groups, like they spread you out and stuff. There's labs that are, that aren't in person. So I mean, it's just kind of harder to make those connections with people." – Tutee 4

Tutee 4 mentioned that they greatly missed the interaction with professors and TAs but then moved onto speak more generally about how having interactions with other chemistry people would be beneficial.

"I'd probably say a big part of it, is the lack of interactions with professors and TAs. So like, we have our lectures, we don't usually ask questions there in the middle of it. And then we have recitations which are helpful, but in the end, it's only 50 minutes. Then you have like lab hours and stuff. But it's just like if we had in person labs, or more opportunities or review sessions to meet with people and see examples or work things out, I feel like people would understand it more." – Tutee 4

When asked whether they thought this semester being online made them more likely to want a tutor, Tutee 1 confirmed that was the case and indicated that not having interactions with other students was part of that.

"Yeah, I definitely do. Like earlier, like, when you go to labs, you can talk to friends and talk to it with talk through it with them. And it's almost like, my mom was like, 'think of it [tutoring] as a lab partner.' I'm like, 'I don't have labs, so I can't think of it.' 'But like, just think of it as someone just to help.'" – Tutee 1

Tutee 1 had strong negative feelings toward their professor and especially their TA as seen in research question 1, but they had more thoughts on how their relationship with their professor was mediated by the online nature of the course.

"So like, I just miss the interaction and the personality aspect. That's why the videos also suck because you can't even see the professor's like, all you see is just their screens. I don't know what a single Professor looks like." – Tutee 1

While Tutee 1 keyed in upon how not seeing the professor made it hard to have a relationship with them, Tutee 2 approached the same concept from the opposite angle.

"I feel like finding that relationship with a TA is really slim given COVID and also majority of classes anymore online. So it's really hard to have a relationship like that with a TA when they've never seen your face." – Tutee 2

There is a strong sense of missing the connection with other people running throughout all these quotes. When people do not have their need for relatedness fulfilled, they can be isolated and lonely (Vansteenkiste et al., 2020). A satisfied relatedness need can manifest as feeling as though a professor or TA values or respects them and that their peer group accepts them (Niemiec & Ryan, 2009). For these tutees though, it is not merely a matter of their need for relatedness remaining unfulfilled, they are feeling it actively suppressed due to the online nature of the course. They are not able to see and interact with other people, they are not able to form relationships, and they are not able to use those interactions and relationships to foster their learning of chemistry.

4.2.3 Lectures are Hard, Labs aren't Useful

Tutees expressed a general dissatisfaction with the chemistry course being online which can be summed up as a feeling that online lectures were harder than in-person lectures and that online labs felt useless compared to in-person labs. For the most part, this can be understood through the lens of SDT as pertaining to competence as the tutees felt ineffective and helpless when dealing with the online course as well as their need for autonomy (Vansteenkiste et al., 2020).

Tutee 2 expressed a general dissatisfaction with the course being online, attributing their dissatisfaction to it being hard to pay attention.

"And so far, it's been difficult because it's online. Because it's hard to pay attention to a lecture online." – Tutee 2

They went on to compare their chemistry course to their major course, which was in-person, to help illustrate what they felt was different about online versus in-person.

"So I guess it'd be easier probably to compare it to my major specific class, which would be my Speech Language and Hearing science class. And it is in person, I have a lab for two hours or a two hour lecture, so to speak. And I can sit down and zone in, you know, and I can take notes the entire time, and I'm in sitting in person in class, I have a lot easier time understanding that class." – Tutee 2

Tutee 2 found that they were more easily able to pay attention and focus on the topic when present in an in-person environment. Tutee 3 also mentioned that they found it hard to pay attention to the online lectures, but their professor also posted recordings of the lectures which Tutee 3 found much easier to follow.

"You can watch it live, but he goes really fast, so I just wait for it to be recorded and posted. Because I can't keep up with them. And then I'll just pause the video when I need to." - Tutee 3

Online content can be delivered either synchronously or asynchronously and each have their benefits and drawbacks. Tutee 3 found that the ability to interact asynchronously with the lectures helped alleviate some of the troubles they were facing with the online aspect of the course. Overall, the online lectures were largely an issue of competence for the tutees. They felt unable to grasp the information presented and did not feel their skills and knowledge growing contributing to them not having their need for competence satisfied by the online lectures. Additionally, there is a layer of autonomy within this issue as well. The tutees feel forced into this learning environment, violating their sense of autonomy. However, being provided with the option of synchronous and asynchronous lectures did provide more autonomy satisfaction to Tutee 3.

Tutees were also dissatisfied with the online lab portion of the course. While tutees found the online lectures to be difficult, they found the online labs to not feel useful or engaging. Tutee 5 expressed general dislike of the online labs due to them not being hands on.

"I'm a very visual learner. And a hands on learner. So the online portion of it is not the greatest for me." – Tutee 5 $\,$

Tutee 1 echoed their thoughts about the inability to have hands on interactions.

"And then you go to the lab portions and you it's just you're watching someone else do it and you can't say you're like, 'Okay, what do I do with that video? Like, how do I apply it when I'm not doing it? And how am I I'm not experiencing it?' Like labs are supposed to be hands on. And we're not doing the hands on anymore." – Tutee 1

Both Tutee 1 and Tutee 5 felt that the labs being online, and thus not hands on, was a detriment for them. They didn't feel like they were learning or growing their skills, thus their need for competence was left unsatisfied.

When asked if they felt like they were learning anything from the labs, Tutee 3 felt that they would be learning more if the lab was in person.

"I mean? Yes and no. I think if it was in person, it would be, I would learn more and I would retain the information better. And it'd just be more fun too than just clicking the video." – Tutee 3

Tutee 4 expressed similar concerns.

"Personally, I don't really like it [online labs]. I much rather would like to see things in front of me and be able to understand it. [...] I'd much rather prefer in person one, I think it's just easier to see it. If you can make a mistake more easier, which you can learn from." – Tutee 4

Tutee 2 summed up their feelings about online labs by explaining that they felt like a waste of time, time which could perhaps have been more effectively spent in other ways to learn chemistry better.

"Um, I feel that the labs are a waste of time. Just because I feel like they take so much of my time when I could have been rewatching a lecture, so to speak, and understanding it that way. So I do feel like it's a waste of time." – Tutee 2

The issues with online lectures and online labs weave between issues of competence and autonomy in regards to SDT. With all lectures being online, some tutees feel that they are not able to learn this way, leaving them feeling unsure about the concepts and helpless, both of which are telltale signs of their need for competence being left unsatisfied. Tutees also felt forced into the online situation, violating their need for autonomy. However, offering both synchronous and asynchronous options for lectures may help alleviate this feeling. For the labs, many tutees felt that they were not learning anything from the experiences, they did not find themselves learning new concepts or skills, nor did they find themselves deepening their current knowledge or skills. Because of this lack of learning or deepening, their need for competence is left unsatisfied.

4.3 Research Question 3

The third research question was: what are the tutees' hopes and expectations of what tutoring can provide for them? The first two research questions were explicitly about the context of the online chemistry course but research question 3 is about what tutees feel that tutoring can

provide from them that they are not receiving from the course as it is. The answers to this research question still pertain to the chemistry course though because by understanding what tutees feel like they need can help illuminate what the course is lacking. The major themes found were: tutees hoped that a tutor would be able to break down the information for them; tutees expected that a tutor would be able to provide personalized instruction; and tutees hoped that tutoring would help prepare them for the future. These themes, the relevant codes, and the corresponding SDT needs are summarized in Table 4.3.

Table 4.3. Summary of relevant information for Research Question 3.

Research Question: 3. What are the tutees' hopes and expectations of what tutoring can	
provide for them?	
Relevant codes: Tutoring hopes and expectations, tutoring motivation	
Themes	Self-Determination Theory
Break things down	Competence
Personalized instruction	Competence & Relatedness
Prepare for the future	Competence & Extrinsic Motivation

4.3.1 Break Things Down

One of the most common feelings amongst tutees was the hope that a tutor would be able to *break down* topics and concepts covered in the course. One of the important aspects of competence according to SDT is that students should feel challenged but still able to meet and overcome those challenges (Niemiec & Ryan, 2009). The tutees found themselves presented with material and concepts that were too challenging and thus desired a tutor to help break those challenges down into conquerable sizes.

Two of the tutees explicitly used the words "break down" when asked questions about what they would want from a tutor or what they hoped having a tutor would do for them. Tutee 1 expressed a desire to have things broken down to a basic level as a starting point for learning.

"So I just hope the tutor can like, really just like break it down to the basic level. And then we can build up from there to make sure I have like a firm understanding of it." – Tutee 1

Tutee 5 expressed very similar thoughts.

"More or less break down the information that the professor had given me into more terms or better terms that I could digest and understand. Because I mean, going to a chemistry lecture and just listening to that doesn't, doesn't always give you the best explanation of how something works or how to do something in that sense." – Tutee 5 $\,$

Both Tutee 1 and Tutee 5 wanted a tutor to "break down" information into smaller, more basic or fundamental pieces that could be more easily understood. Tutee 5 went on to talk about how they didn't feel that they could get that from a lecture. While Tutee 5 says they want "information" broken down, Tutee 1 is less explicit about what they want broken down. It is likely that they are talking about the concepts of the course because after "it" gets broken down, they want to build things up and understand things. Other tutees discussed how they were having trouble with the concepts of the course and desired help from a tutor with that aspect.

While Tutee 2 did not use the language of "breaking things down," they did express a similar feeling when discussing the type of help they wanted from a tutor.

"Um, I think working with a tutor would definitely help me understand specific concepts better, because sometimes when you're watching a lecture, all of the concepts that they talk about in the video can just run together, you're not really sure what specific topics you talked about, if that kind of makes sense. So I feel like working with a tutor could kind of help pinpoint what was talked about and what those topics are, instead of it all just being one blob in my mind, it will kind of be separated out if I talk about it with a tutor." – Tutee 2

Tutee 2 found that concepts blended together and wanted help separating the concepts into specific topics. This separating is similar to breaking down as both involve taking one thing and turning it into several, easier to manage things. They expressed this desire to separate concepts again later in the interview.

"So I think working with [the tutor] will help me organize my thoughts in a sense, and understand each concept individually instead of understand them all together." – Tutee 2

Tutee 2 wasn't the only tutee to hope that a tutor could help "organize" their "thoughts" as Tutee 1 used the exact same phrase when discussing what they thought a tutor could do for them.

"Well, I thought a tutor would help me on, like, organize my thoughts, organize problems, like 'when you see this, you think should think of this,' for some units just explain what they were trying to convey, and like trying to talk me through like, what, where I went wrong in my understanding." – Tutee 1

Just like Tutee 2, Tutee 1 wanted a tutor to organize their thoughts when it came to the concepts of the course. However, concepts are not the only things that Tutee 1 wanted a tutor to organize or break down for them as they also wanted help organizing problems.

Tutee 1 had a lot of thoughts about the questions and problems they were asked to solve in their chemistry course (see Research Question 1 and "the trouble with word problems"), and they also wanted their tutor to break down those questions for them.

"But like, yeah, I definitely need help breaking down what they want, what they are looking for where these come from, you know? [...] And like, maybe even a little assistance of how to get there. Like how to, like handle if you see this kind of problem, you should kind of know, this is the unit, this is the steps, the way to go." – Tutee 1

Tutee 1 didn't just find the chemistry concepts difficult or the online aspect of the course to be problematic, but they had a hard time understanding what was even being asked within word problems. They hoped that working with a tutor would allow them to break the questions into smaller pieces that could be understood. They were also hoping that a tutor could help them know what to do with those pieces on they were broken down to a level that could be addressed.

Tutees' desire for things to be broken down or organized is a reflection of their need for competence remaining unfulfilled. The chemistry course was presenting concepts in such a way that the tutees were not able to understand what parts constituted the whole and thus felt they could not understand the whole. Thus, the tutees were left in a situation where the concepts as a whole were too difficult but also they felt that they didn't have the tools to make that whole into smaller parts that could be understood. Their need for competence was unsatisfied in two ways, both by the concepts themselves and by the task of breaking down the concepts.

4.3.2 Personalized Instruction

Another common hope amongst the tutees was that tutoring would be able to provide them with more personalized instruction. As has already been discussed, tutees did not feel as though there were able to have a relationship with their professor or TA for a variety of reasons and they hoped that working with a tutee could help with that absence.

One of the most common ways that the idea of personalized instruction came up was in contrast to what the tutees felt was the decidedly impersonal online lectures. Tutee 4 similarly felt that one of the most positive aspects of working with a tutor was the personalized help that could be provided, and suggested that it was even more important in college due the large amount of students that professors and TAs must handle.

"So I mean, I don't know I've always trusted tutors. I feel like no matter what you do, unless you have like a really bad tutor, a tutor is always going to help. Because it's just a more personalized experience. It's mainly focused towards you. And it's a lot easier and a lot more helpful in college because classes are so big." – Tutee 4

This idea of large lectures and the impersonality of those contexts came up again when Tutee 5 was asked what they thought a tutor would be able to do for them, Tutee 5 mentioned their trouble with lectures and how a tutor could help.

"Like, [the professor] is not really designating that lecture to the students that aren't understanding it. He's giving that lecture based on the idea that all of this students are going to have a grasp of it and understand what he's saying. So I mean, the tutor offers just like an easier breakdown of that knowledge if they don't understand it, like and it's more personalized too so like, if you don't understand just a specific aspect of that lecture, that tutor can help you to break down that part of that lecture and make sure that you understand that which will help you in turn to understand everything else versus just the big lump sum of knowledge given from the lecture." – Tutee 5

Tutee 5 points out that lectures are generally directed at students that are doing well in the class and understand what the professor is talking about already. Working with a tutor would then provide Tutee 5 with the ability to work with someone that can respond to their needs and provide them personalized learning as opposed to the general, impersonal learning present in the lecture. Tutee 5 specifically mentions that the personalized aspect of tutoring allows for more in-depth discussion of the problem areas while the parts that are understood can be skipped.

This wasn't the only time that Tutee 5 expressed this feeling. They later expanded upon the idea of the personalized aspect of tutoring.

"Because I mean, going to a chemistry lecture and just listening to that doesn't, doesn't always give you the best explanation of how something works or how to do something in that sense. But having that ability to go to that lecture and get those notes and then take that to a tutor and get a another, like more personalized explanation of how to do something, or maybe I'm doing something wrong, so how to fix it. Like that would -- yeah, that's probably the biggest help." – Tutee 5

Tutee 5 values having the ability to take the lecture material that they may not have understood and work through it with a tutor to get the personalized instruction that they feel is valuable. This is very similar to what Tutee 2 talked about despite them not using the phrase "personalized."

"Um, I think working with a tutor would definitely help me understand specific concepts better, because sometimes when you're watching a lecture, all of the concepts that they talk about in the video can just run together, you're not really sure what specific topics you talked about, if that kind of makes sense. So I feel like

working with a tutor could kind of help pinpoint what was talked about and what those topics are, instead of it all just being one blob in my mind, it will kind of be separated out if I talk about it with a tutor." – Tutee 2

Tutee 2 wants to use the tutoring to supplement the lecture and take advantage of the personalized nature of tutoring to come to a better understanding of the lecture material.

The issue of competence can be found in the fact that the lack of the personalized instruction of a tutor left these tutees feeling confused and helpless, a common feeling when facing an unsatisfied need for competence (Niemiec & Ryan, 2009). Tutees hoped that working with a tutor would allow the tutees to get personalized instruction on the concepts of the course that were causing them problems thus helping to satisfy their need for competence. Additionally, though not discussed explicitly by the tutees, by the very nature of being personalized, the tutoring they desire fulfils their need for relatedness as well. In order for the tutor to provide personalized instruction the tutor and tutee need to be able to communicate and the tutor needs to be respectful and listen to their tutees needs. People have their need for relatedness satisfied when they feel respected, valued, and heard (Niemiec & Ryan, 2009; Vansteenkiste et al., 2020), and so a tutor providing personalized instruction will help tutees feel more relatedness.

4.3.3 Prepare for the Future

Within SDT, there are essentially five levels of motivation based on how intrinsic or extrinsic it is and within each level there are a diverse multitude of different external or internal sources for those various motivations. While it is not surprising that none of the tutees expressed an intrinsic motivation for seeking out tutoring (i.e. they did not seek out tutoring because they thought tutoring would be fun) several of the tutees did express some degree of identified regulation. Identified regulation is essentially the midpoint between purely extrinsic, non-autonomous motivations and intrinsic, fully autonomous motivations. Identified regulation is when someone's motivation is tied to perceived value of the experience and for students is often linked to seeing it having value for their future. This is idea of future value was a common theme amongst some of the tutees when discussing why they decided to use tutoring.

Tutee 2 consistently expressed throughout their interviews that they were looking for help with the concepts of the course and that they found the problem solving to not be a problem. This is just one example of many: "I guess, when I went into tutoring, I was having a hard time with the concepts but I could do the equations when I was given the homework assignment." – Tutee 2

Eventually, Tutee 2 went a little deeper with why they were so concerned with the conceptual aspects of the course, tying their difficulty with the concepts with wanting to make sure they were prepared for future chemistry courses.

"I'm doing fine in the class right now. So I really think I just needed to understand the concepts better because I can get through the busy work in the class and get 100 percents on them. That's not hard for me, but I do need to understand the concepts better. And I think that's just me thinking ahead for taking Chem 116. And going ahead and taking other chemistry classes. I need to understand it not just get through the class, I guess." – Tutee 2

Tutee 2 sees value in tutoring at this point in their chemistry journey because the worry that future classes will be potentially more difficult. It is understandable to believe that if the first chemistry course is presenting complicated, confusing, or difficult concepts that future courses would be even more intimidating. It may be that Tutee 2 is reacting to that fear or it could be that they want to build a strong, solid base of chemistry knowledge when in their introductory course so that when they encounter the more advanced courses they have that knowledge to draw from.

Tutee 3 similarly talked about how they wanted a tutor as part of preparation for the future, but not in the same conceptual sense as Tutee 2. Tutee 3 worked with a tutor for their high school Spanish class, and they said the main reason was in order to get a good enough grade so that they could get into Purdue.

"I wanted a good grade. And I needed at least like a C, because to get like, the academic honor diploma or whatever you need for to get into Purdue and stuff. So I wanted to make sure I definitely pass and get the best grade I could." – Tutee 3

When it came to why Tutee 3 wanted to get a tutor for their chemistry course in college, they expressed an extremely similar sentiment.

"I decided to [get a tutor] because I want to get into pre PA. And you have to have like, really good grades, especially in all the science classes. And I could tell this class was going to be difficult from the start. And there was just, there was really poor communication with the class at first too, and I was like, I don't want to have like a super rough start. So I was just trying to get a tutor as soon as possible." – Tutee 3

Again, Tutee 3 sought out tutoring in order to get a good grade so that they are able to qualify for the school or program that they desire. Typically, grades serve as an example of the least

autonomous, most externalized form of motivation. However, in the case of Tutee 3, the grades themselves do not seem to be the motivation but what a bad grade would keep them from being able to take part in. Thus, the motivations for Tutee 3 seem to exist in a blended space between external and integrated regulation with their focus on an outer punishment now affecting their future options.

While Tutees 2 and 3 expressed at least a degree of integrated regulation and thus a certain amount of internalization of their motivations, Tutees 4 and 5 were much more on the external end of the motivation spectrum with very little autonomy expression. Tutee 5 expressed fear at failing chemistry and what they would mean for them.

"Um, I am on academic probation, from failing bio 203 first semester. And I needed to get out of academic probation, but I also needed to pass chemistry because I did not want to retake it or fail it again. Because if I, if I fail another class, or in the sense that I just don't pass it or I don't know what would happened if I drop it. I really don't. But um, it's more of like, if I didn't pass chemistry, I would have had to reapply to Purdue. And I did not want to reapply to Purdue. The best bet was just for me to reach out to a tutor." – Tutee 5

Due to the fact that Tutee 5 focuses not just on the grade but what the grade would mean, similarly to Tutee 3 there is a degree of internalization of motivation present. However, where Tutee 3 was looking for good grades in order to get a desired outcome, Tutee 5 is looking to avoid bad grades to avoid undesirable outcomes. This pushes the motivations of Tutee 5 down the scale toward the less autonomous, more externalized side of the spectrum.

Tutee 4 expressed even less internalization of motivation than Tutee 5. When asked why they decided to work with a tutor this semester, Tutee 4 replied:

"Um, well, the main reasons just because I did bad in the test, and I told my mom, and she got mad at me. So I mean, it's just kind of like something I had to figure out. But, um, I don't know I've always liked tutors." – Tutee 4

Despite continuing on to discuss how they feel that tutors are valuable due the personalized instruction they provide (see previous section) which implies a small degree internalization, it seems that the initial catalyst for their decision for entirely external. Not only was their decision based upon a bad score on a test, but it was the reaction of someone other than themselves to that score that ultimately motivated them. This would fall squarely on the side of external regulation as all the initial factors influencing their decision are outside of themselves.

The theme of the future as playing a role in motivation was present amongst Tutees 2, 3, and 5 to varying degrees. While Tutee 2 viewed tutoring as a way to prepare for future chemistry courses, both Tutees 3 and 5 viewed tutoring as something to deal with grades. Tutee 3 wanted tutoring to get a good grade so that they could get into the program they wanted in the future while Tutee 5 wanted tutoring to avoid a bad grade so that they wouldn't need to reapply to Purdue. These are similar in that tutoring is something that impacts a grade that can then impact something else in the future, but for the avoidant nature of Tutee 5's motivations is less autonomous than the motivation of Tutee 3. Finally, Tutee 4 does not have concerns about the future the way the previously discussed motivations do and is essentially completely on the external side of the motivation spectrum. More internalized motivations are generally viewed as preferable as when the motivation is an external punishment, when that punishment is removed, tutoring would cease regardless of whatever other benefits tutoring has to offer.

CHAPTER 5. DISCUSSION

When looking across all the research questions, tutees were found to have issues with all three aspects of SDT. The needs as defined by SDT, competence, relatedness, and autonomy are not independent from each other and often contribute to the satisfaction of each other in a synergistic fashion. While this analysis generally looks at them separately, the interrelatedness of the needs should not be forgotten.

The most common need as defined by SDT that came up amongst the tutees was the need for competence and this need was interwoven with the other needs in various ways throughout the results such as with relatedness when looking at tutees' desire for personalized instruction or with autonomy when tutees felt like they had to teach the material to themselves due to the online nature of the course. It is understandable that competence would be a need commonly unsatisfied amongst students seeking tutoring as a satisfied need for competence has been linked to achievement and retention (Hilts et al., 2018), and competence is often a key component of research on tutoring (Blanch et al., 2013; Duran Gisbert & Monereo Font, 2008; Hänze et al., 2018). However, tutees also felt unsatisfied needs for both relatedness and autonomy that were not intertwined with competence. Working with a tutor then became a way for the tutees to satisfy their need for competence, relatedness, and autonomy that their chemistry courses left unsatisfied. Chiu (2021) found that basic needs for autonomy, competence, and relatedness were the same regardless of whether a course is in person or online, and while those needs may manifest in different ways, the needs themselves are the same.

5.1 Unsatisfied Need for Competence

An unsatisfied need for competence can be manifested in a variety of ways, but the resultant feelings can be understood as feeling ineffectiveness, helplessness, or like a failure (Vansteenkiste et al., 2020). The tutees that participated in this study frequently expressed feelings that can be understood in terms of an unsatisfied need for competence stemming from their experiences with the chemistry course they were enrolled in.

There were many ways in which their courses left students with an unsatisfied need for competence, including the speed at which the course was conducted and the types of problems asked of tutees. In line with this, tutees hoped that a tutor could provide personalized instruction specifically breaking down information into smaller bits of information as well as helping the tutee prepare for the future. Breaking information down into smaller, more manageable sizes is an example of scaffolding. Scaffolding as a metaphor for learning has its basis in work by Woods, Burner, and Ross (1976) and Vygotsky (1978). Scaffolding is a crucial form of support for learners, and one common form of scaffolding is creating sub-tasks that allow a challenging task to be more approachable (Wilson & Devereux, 2014). This is exactly what tutees wanted when they wanted their tutor to break information down, the only difference being the task in this case was a concept instead of a problem to solve. Several of the tutees expressed multiple times throughout their interviews that it was the conceptual aspects of the course that gave them the most trouble, not the problem solving aspects, so the scaffolding necessary is slightly different. The metaphor of scaffolding is still useful as it shows how the tutees were able to reach greater understanding of concepts with the scaffolding of smaller bits of information just like a challenging task can be achieved by creating sub-tasks. Breaking down not just problems into smaller steps but concepts into smaller chunks creates useful scaffolding and it may allow for more connections between topics to be made. The tutees spoke about how it felt like the course moved from topic to topic too quickly, but if the topics are broken into smaller chunks, and connections are made between the chunks in one topic to the chunks in another topic, it may lessen that feeling that the course is moving too quickly.

The online nature of the course in particular created several additional problems as tutees felt that it forced them to teach themselves and that the lectures and labs were not useful in their efforts to learn. There are several studies focusing on the semester in which the pandemic forced classes to go online that note how these courses transitioned into a virtual learning environment they were not designed for (Daniel, 2020; Goodman, 2020; Marinoni et al., 2020). The tutees that participated in this study were not in chemistry courses when the pandemic struck, but they did not find their courses to be particularly well-suited to the online environment. Tutees found themselves feeling like they were teaching themselves chemistry as the course was not providing the resources they needed. For some, this meant trying to understand the content by seeking outside sources such as YouTube videos or Khan Academy lectures. The idea that students should teach themselves is in some way or another a key component of many learning strategies from active learning (Abramczyk & Jurkowski, 2020; E. G. Cohen & Lotan, 2014), Peer-Led Team Learning

(Lewis, 2011; Tullis & Goldstone, 2020), process-oriental guided inquiry (Chase et al., 2013; Vincent-Ruz et al., 2020), and flipped classrooms (Luo et al., 2019; Milman, 2012), but a key difference is that all of these strategies present resources for students to practice and refine their knowledge and skills in order to satisfy their need for competence while the online courses the tutees took part in did not facilitate this type of interaction. According to Wilson and Devereux (2014) building on work by Mariani (1997), this type of environment is high challenge and low support where students may feel that tasks are impossible or unreasonable leaving them feeling frustrated, thus leaving their need for competence unfulfilled. All the combinations of low & high challenge and low & high support and the feelings associated with each can be seen in Figure 5.1. The ideal region of the matrix for satisfying competence is the upper left, high challenge and high support (Wilson & Devereux, 2014).



Figure 5.1 The four types of learning environments possible based on either high or low challenge and high or low support as well as the feelings or outcomes associated with each environment. The optimal zone for supporting competence is high challenge with high support.

The online learning environment would benefit from increased support and increased access to professors or TAs to supply the support that is needed to properly scaffold student learning. It is important not to just advertise availability by reminding students about resources like office hours but to purposefully implement time in the course for interaction between students and their professors and TAs. Not only would this provide the missing ingredient to bring the

online environment more in line with the active learning strategies previously mentioned but it would also help with the need for relatedness that is often left unfulfilled by the online nature of the course.

5.2 Unsatisfied Need for Relatedness

An unsatisfied need for relatedness often results in people feeling isolated, excluded, and lonely (Vansteenkiste et al., 2020). Chiu (2021) found that relatedness was more important than ever due to the pandemic and online nature of courses. Classically, autonomy support has been the need most focused on by those in education, but the pandemic has removed much of the social support that students rely upon thus increasing the need for relatedness support in education (Chiu, 2021). College students have typically been found to have higher levels of stress, anxiety, and depression compared to the rest of the population and those levels rose even higher with the pandemic (Lee et al., 2021). The tutees in this study reflected upon two main sources of relatedness that they were missing from their experience with their chemistry courses: relatedness in reference to their professor or TA and relatedness in reference to their peer group.

The tutee's lack of a relationship with their professor or TA was a large motivator for seeking out tutoring, and the online nature of the courses exacerbated this issue for many of the tutees. When people have a positive relationship with their professor or TA and thus a satisfied need for relatedness it can increase what they are able to learn as well as increase their sense of belonging in the course (K. N. White et al., 2020). Petillion and McNeil (2020) found that 80% of students surveyed indicated that they felt like they were less able to connect with their professors and TAs due to the online aspect of their chemistry course. One of the reason cited was the difficulty of communication and the long gaps between initiating communication and receiving a reply. This lines up well with the concerns expressed by the tutees in this study as they too had negative views about email communication, both the difficulty of understanding explanations through email as well as the time it could take to get a response. One aspect that was brought up by the tutees in this study was how they were less likely to reach out to a professor or TA because they had never met and neither party knew what the other looked like. White et al. (2020) point out how attending office hours for example can strengthen relationships between students and professors or TAs, but if the student does not feel comfortable attending due to the lack of a current relationship, resources like office hours do not get to exhibit their beneficial effects. However, one

tutee experienced a hostile interaction with their TA that was not due to the online nature of the course, showing that an unsatisfied need for relatedness and a having a negative relationship with a professor or TA might not only be due to the online nature of the course. While it is certain that the online learning environment creates many challenges for satisfying relatedness needs, it is not the only source of unsatisfied relatedness needs and general care should be taken to ensure people in the course feel respected and connected.

The online nature of the courses did not just affect tutees' relationship with their professors and TAs but made tutees feel a general sense of disconnection from all people, specifically other students. The tutees felt isolated and lonely due to both the online nature of the courses as well as the global pandemic forcing people to stay home much more often than they might otherwise in line with other reports on mental health and the pandemic (Lee et al., 2021). The need for relatedness in SDT is related to the concept of belonging. A sense the one belongs in a course can elicit feelings of being included, respected, welcomed, and valued by a peer group (Edwards et al., 2021; K. N. White et al., 2020), feelings associated with a satisfied need for relatedness. While the theory surrounding belonging in a course encompasses more than just the social aspect, it is the social aspect that is key here. Learning can be viewed as a collaborative social process (Vygotsky & Cole, 1978) where the social aspect is vital to the learning aspect and certainly a necessary component of belonging and relatedness. The pandemic effectively removed the social aspects of the course such as working together in small groups in lecture or the laboratory portion which can be a rich environment for social interaction and collaborative learning. This caused a great deal of social isolation for the tutees, creating an environment where it was hard to understand whether they belonged.

Finally, one of the aspects of tutoring that tutees found most appealing was the personalized nature of the instruction they received, highlighting the positive feelings that are associated with a fulfilled need for relatedness as opposed to the negative feelings induced by the unsatisfied need for relatedness from their chemistry courses. The care and respect necessary for a tutor to tailor their tutoring style to fit the needs of their tutees by providing personalized instruction made the tutees feel understood and respected, fulfilling their need for relatedness. However, the personalized instruction does not address the tutees sense of belonging in the course or with their peers as the social context necessary for course-level belongingness is still absent. It is likely that a tutor, often being of a similar age to their tutee, could fulfill some social aspects and provide

some context that could affect perceived belongingness, but this would require further research. The issue of belongingness aside, the tutor provided a new source for relatedness that can help the tutee feel connected and respected, leaving them better able to handle the chemistry course. Ideally, instructors can find a way to encourage social interactions to help eliminate the sense of isolation and loneliness that leaves the need for relatedness amongst peers unfulfilled. Additionally, professors and TAs can engage in intrusive behaviors such as initiating conversations with students or reaching out to students that are struggling (K. N. White et al., 2020). While relatedness support has been found to be more pressing during the pandemic (Chiu, 2021), autonomy support is still a vital part of an educator's role.

5.3 Unsatisfied Need for Autonomy

An unsatisfied need for autonomy leaves one feeling pressure, conflict, like decisions are being made for them, or that they are forced to do things against their will (Vansteenkiste et al., 2020). The concept of agency has been linked to autonomy in the literature (Luo et al., 2019). The distinction that the literature makes is that agency deals with sociocultural factors in addition to autonomy (Ahearn, 2001; Rappa & Tang, 2013). However, the autonomy that is being referenced in these comparisons seems to be more in line with a typical definition of autonomy that does not reflect that extra nuance that SDT provides. Within SDT, autonomy is not a matter of working alone or managing one's own learning, but feeling like one is able to work the way that they want to whether that is independently or as part of a collective (Ryan & Deci, 2020; Vansteenkiste et al., 2020). Thus, both agency and the SDT version of autonomy deal with the power to make choices. Agency has a great deal more in common with the SDT definition of autonomy than the standard definition. However, agency and autonomy are not a perfect match and there are some differences in results between this study and studies that use agency.

The biggest concern for the tutees in regards to online learning was that it left them feeling like they had to teach themselves the material which was not how they would choose to approach learning chemistry. I have already mentioned how the online learning environment resembles a flipped classroom in some ways while lacking some of the scaffolding and support offered by the flipped classroom. In their study of student agency in a flipped classroom, Luo et al. (2019) studied three different flipped classrooms with three different styles. In the student directed course, students decided what questions were discussed and then discussed those questions in small groups.

In the teacher facilitated course, questions were decided upon jointly by teacher and student with students elaborating on key points in lecture. Lastly, the teacher led course had the teacher deciding what questions to go over and then engaged the students in a Q&A style problem solving session. The researchers assigned the student directed course as high student agency and the teacher led course as low student agency. They found that the course with least amount of agency had the highest student performance and highest evaluation ratings. Unfortunately, this potentially misses the bigger picture that SDT can offer as all the needs must be satisfied and while this potentially satisfied autonomy (though not necessarily as it is unknown how the students felt), it likely left them without enough scaffolding, leaving the students without enough support. This is exactly what the tutees in this study faced in their online chemistry courses as on the surface, they have independence and agency but not the agency they desire and thus not autonomy. Additionally, the online environment, like the student led flipped classroom, lacks the competence support that scaffolding can supply.

Additionally, autonomy is often considered an important factor in understanding the degree to which people's motivations are intrinsic or extrinsic. While all of the needs are important for the internalization of motivation (Milyavskaya et al., 2014), the amount of autonomy associated with the stages of internalization was vital to understanding the tutees motivations. Some of the tutees had internalized their motivation and wanted tutoring to prepare for future courses while other tutees were more concerned with avoiding negative consequences and thus did not display internalization of motivation. The more internalized their motivation was, the more autonomy they felt when participating in the tutoring. In a study of flipped classrooms, SDT, and motivation, Zainuddin and Perera (2019) similarly found that students had extrinsic motivations and lamented the lack of intrinsic motivation. It must be remembered that intrinsic motivation is when one does something merely because it is enjoyable to do, and while that is desirable, it is not necessary. Extrinsic motivation is a spectrum and one can perceive great value in a task and complete it without enjoying it. Internalization of motivation, moving from outside punishment/reward toward value and self-identification, is highly linked to satisfaction of all three SDT needs. Students need to see the value of what they are learning, not just be told it is necessary.

CHAPTER 6. CONCLUSION

This study used self-determination theory to examine the needs and motivations of people seeking tutoring for general chemistry during the COVID-19 pandemic. It was found that the chemistry course was not satisfying tutees needs for competence, relatedness, and autonomy and that many of the issues with the course were exacerbated by the online learning environment forced by the global pandemic. Tutees did not feel competent in the course due to a lack of adequate scaffolding making them feel like they had to teach themselves, that the course moved too fast, and that the word problems were deliberately more difficult than necessary. The online environment made this even more difficult for the tutees to deal with as it removed many of the relatedness support that is present in in-person courses leaving tutees with a more unsatisfied need for relatedness than would otherwise be present. They felt at best the lack of a supportive relationship with their professor or TA and at worst a negative, almost antagonistic, relationship with their professor and TA. Many factors contributed to relatedness needs remaining unsatisfied including the difficulty of email communication and the lack of face-to-face interactions, both of which were direct results of the online nature of the course. While it might be believed that the more hands-off nature of the online course would increase autonomy for students, it is important to remember that autonomy and independence are not synonyms, and due to this change in course structure being forced upon the tutees, their need for autonomy was largely unsatisfied. The lack of scaffolding that prevented the satisfaction of competence similarly prevented the satisfaction of autonomy for the tutees as while they were acting on their own, teaching themselves the material, they did not feel competent enough to perform that task and felt forced into this situation which violated their desire for autonomy.

In addition to all the ways the online chemistry course left tutees needs for competence, relatedness, and autonomy unsatisfied which indirectly led tutees to seeking tutoring, tutees were found to have a range of direct motivations for seeking tutoring. Some tutees expressed *external regulation*, the least internalized kind of motivation, by talking about things like their parent being disappointed in their test grade or wanting to get good grades to avoid being kicked out of their program. Other tutees showed greater internalization by expressing *identified regulation* where they see value to getting tutoring as it will help them with future classes in college. No tutees exhibited intrinsic motivations, but that is not a concern as intrinsic motivations deal with pleasure

and enjoyment, and while we can strive to inspire love of learning in students where they will engagement with the concepts purely because it is so much fun that is not necessary for people to be internally motivated.

6.1 Implications

This study is explicitly about chemistry tutoring and the motivations behind those that seek such tutoring. Tutees were found to have unsatisfied needs for competence, relatedness, and autonomy and it is thus important for tutors to be aware of these needs and to work with their tutee to help satisfy the needs for the tutee. As was evident in the results, while all tutees had unsatisfied needs, the ways in which those needs were left unsatisfied were different and it is important that tutors are able to work with their individual tutee to help them with what they are struggling with. Any sort of one-size-fits-all advice for tutors is likely misguided as it would just echo the inflexible course that is already leaving tutees with unsatisfied needs.

In addition to the explicit tutoring motivations, this study shines an implicit light on the conditions in the chemistry courses and we can use this to help make our chemistry courses more able to satisfy students' needs. All students will have their needs satisfied in different ways making course-wide changes challenging but still possible. For online courses in particular, relatedness support is extremely important. Professors and TAs should record lectures with video of themselves if possible to allow students a chance to get to know them a little better. Students also need more time to work with other students in a collaborative process. The online learning environment needs more scaffolding to allow students to have a better chance at satisfying their need for competence. For autonomy, students respond positively to having the option of live lectures or recorded lectures and implementing both synchronous and asynchronous aspect of the course is a good idea. Professors and TAs need to reach out to students whenever possible and attempt to form relationships so that students will be more likely to be comfortable asking them for help. Additionally, professors and TAs should engage in intrusive behavior as described by White, et al. (2020). This will put professors and TAs in a position to better understand their students' needs and thus in a better position to address those needs.

6.2 Future Research

This research could be expanded to analysis the ways in which tutoring can satisfy tutees needs for competence, relatedness, and autonomy not just the ways in which the online chemistry course leaves these needs unsatisfied. There are variety of tutoring techniques and strategies and an analysis of how these tutoring moves and modes affect the SDT needs for the tutees could shed light on the ways in which tutoring can supplement or augment formal education. As was discussed in the discussion, there are similarities between the SDT needs of relatedness and autonomy and the theories surrounding belongingness and agency respectively. Future research could try to understand the ways in which these theories intersect, overlap, and differ to further bridge theoretical gaps and allow for new ways to understand how students feel in their courses.

6.3 Intellectual Merits and Broader Impacts

There is very little research in the cross section of chemistry and tutoring, and even smaller portion of that research intersects with qualitative research methods. Most research in chemistry education relies upon the classroom or laboratory settings as the only locations of learning, neglecting informal learning environments such as tutoring. This study provides an opportunity to understand another way in which chemistry learning can take place and thus this study is novel and brings new avenues of research to the chemistry education field. This study expands on a rarely analyzed context, chemistry, to the wider tutoring literature that is often neglected. Additionally, this was study was conducted during an entirely unique societal context, the COVID-19 pandemic, and thus contributes new knowledge to a heretofore non-existent context. The findings from this study pertain not just to learning within the current pandemic context, but also to general online learning in the future if the pandemic ends.

While the stated research goal of this project is to understand what motivated students to seek out tutoring the findings can be understood as ways in which the course and online aspect as lacking. By knowing what leads students to feel like they need tutoring it may be possible to make those aspects of the course more accessible or approachable, thus improving the experience for all students.

6.4 Limitations

This study is not designed to assess the effectiveness of the tutoring. It has nothing built into it to measure any learning progress beyond how a tutee may feel about their own perception of progress or lack thereof. There are many factors that can motivated a student to desire tutoring and this study only focused on aspects related to the course and the online context. Additionally, there are many other theories that deal with motivation and any of them would offer a different perspective compared to Self Determination Theory as used in this study. With a sample size of five tutees and one tutor, this study is not meant to be generalizable. This study did not analyze issues of identity such as race, gender, ethnicity, or socioeconomic status and a study focused on these would likely have many different insights. The study takes place at a large Midwestern R1 university and the population of possible participants does not represent the population of other places of learning. Similarly, this study is focused on a one-on-one chemistry tutoring context and is not meant to provide insights into other contexts, be they different subjects or different tutoring scenarios within chemistry. This study was conducted during the first full academic year of the COVID-19 pandemic and is incredibly tied to this timeframe. While universities had had time to prepare for the expected online reality of those two semesters, it was still early into the pandemic. The courses have likely changed as the people in charge of the courses become more familiar with the unique context and parts of this study may not apply to new online contexts as methods and technologies advance and change.

APPENDIX

6.5 General Codes

6.5.1 The Chemistry Course Codes

Chemistry (Challenges) – Statements highlighting difficulties with chemistry that relate to the subject itself, whether it be a specific topic (bonding, dimensional analysis, etc) or the culture of chemistry.

• Um, just, I think, like, when I first saw it, it was just like, gonna be honest, I thought molarity and molality were the same thing.

Chemistry (College) – Statements focusing on the experience of college chemistry courses, both in general or specific to the individual's personal experiences.

• Um, I feel like it's flown by, that I've just gotten like a ton of material thrown at me. And it's just every new lecture is a new topic. And I understand that's how it should be. It's just overwhelming sometimes. Because it just feels like I've been thrown into this and just new material just keeps coming at me every week and you're just still trying to learn what last week's material was. So I feel like the last month has just flown by with material.

Lab – Statements that pertain to the laboratory experience (not specific to education level) that include the experiments conducted, the work done in the lab section, or general experiences within that setting.

• I think the labs are more just getting the assignment -- it kind of like tells you direction by direction exactly how to do it. And it almost gives you the answers. So because I don't have to do much of it on my own, like equations are much at -- they'll just give me the equation instead of asking me what equation to use, if that makes any sense. So it just kind of like gives me what I need to solve it instead of me trying to figure it out by myself. So I think the labs are very simple, just because even if I had no idea what's going on in the class, I could still complete the labs. Just because they're so step one, step two, step three based instead of concept based.

Online (Challenges) – Statements that focus on the unique challenges presented by online learning, specifically the forced online nature of the courses due to COVID.

• But I feel like finding that relationship with a TA is really slim given COVID and also majority of classes anymore online. So it's really hard to have a relationship like that with a TA when they've never seen your face.

Professors and TAs – Statements that deal with the ways in which the professor of the course or the TA affect the tutee and their ability to learn.

• And I could go to office hours and do that but I don't know, my professors on a personal level, because all of their videos are recorded and sent to Brightspace. Like I've never talked to them before. That's just weird.

Recitation – Statements that mention recitation and how it may impact the tutee's learning. Is separate from "Other Learning Avenues" as it is an official portion of the course.

• And then we have recitations which are helpful, but in the end, it's only 50 minutes. [...]Well my recitation will usually, we'll go in, he'll ask us or my TA will ask us if we have any questions on a homework or lab. Usually there's like two or three, which will do like an example problem or two. He'll do a really short, five minute little review over the lecture of the past two lectures from the past week. And then he'll work through a kind of study guide that he calls a review sheet. We'll do most of the questions. They're provided to us on Brightspace so we can download. Like, I usually use those to study for tests.

6.5.2 Outside the Course Codes

Chemistry (High School) – Statements focusing on the experience of high school chemistry courses, both in general or specific to the individual's personal experiences.

• [I]t was just a high school chemistry class so I'm sure they were just had to do a certain amount of stuff. But I think if I would have applied myself more in the class, it would be more helpful. Whereas it was just a chemistry class to me in high school, another class to get through, and it wasn't too hard to pass because everybody has to pass it.

Learning Styles & Preferences – Statements where a tutee's preferences when it comes to learning are highlighted, specifically when a tutee self-identifies they types of input they desire.

• Yeah, I feel like I'm more of a visual learner than a audio learner. So I think it could have helped kind of understand that they have different hydrogen bonds for sure. Like, you remember, I remember pictures more easily. So I can associate those things together versus just audibly hearing it.

Other Learning Avenues – Statements that mention other ways in which participants try to learn outside of the classroom (with the exception of tutoring). Examples include: study groups, YouTube videos, textbooks, etc.

• Yeah, if I didn't have a tutor, I probably would have just gone to YouTube and Googled it up. [...] And I'm sure there are lots of lectures on lattice energy that I could pull up from different professors. And I'm sure I would have been able to figure it out by myself, it just might have taken a little longer than just directly talking to somebody that already knows what it is.

Other STEM Courses – Statements that mention other STEM courses (physics, math, and biology

mainly) with a specific focus on differences or similarities between those courses and chemistry.

• "I think physics is just easier, because I don't know, it's like the world that's like, it kind of makes sense that like forces wise, if something's falling, it's due to gravity. And there could be other things happening to it I guess. It's just easier to put it into real world aspects, I guess to like, think about it. Whereas chemistry, you can't necessarily just make sense of it with an example from your daily life."

Other Students – Statements that highlight the importance of interactions with other students,

such as the lack of interaction due to COVID, the usefulness of study groups, friends, etc.

• And then sometimes people will form study groups. Those are kind of tough, though because we're only students, we don't really know how to conduct a good study session. But um, I'd say that's really helpful.

6.5.3 Tutoring Specific Codes

Tutor Characteristics – Statements that deal with characteristics of a tutor that would be desirable.

Examples include: helpful, knowledgeable, easy to talk to, etc.

• Um, it was, she was a very friendly person. So I mean, that's, it's always good to have a friendly tutor. Just someone that's very like welcoming, like, she was a very welcoming person, like she was outgoing, like, she didn't have a problem talking to me or anything like that. So I think more of just the communication aspect of a tutor is the most important in my experience, and she was definitely a very good communicator.

Tutoring Hopes – Statements focusing on what the tutee hopes to get out of the tutoring experience.

• So I just hope the tutor can like, really just like break it down to the basic level. And then we can build up from there to make sure I have like a firm understanding of it.

Tutoring Motivation – Statements that deal with the things that are driving a student to seek out tutoring. "Hopes" is what the tutee wants while "Motivation" is their current situation and the parts of that current situation that they feel tutoring can help with.

• I'm doing fine in the class right now. So I really think I just needed to understand the concepts better because I can get through the busy work in the class and get 100 percents on them. That's not hard for me, but I do need to understand the concepts better. And I think that's just me thinking ahead for taking Chem 116. And going ahead and taking other chemistry classes. I need to understand it not just get through the class, I guess.

Tutoring Outside of Session – Statements the highlight the aspects of tutoring that extend beyond the hour set aside for the tutoring session. For example: email communication and questions between sessions.

• Usually we just communicate scheduling wise and like, I send her the problems I was struggling on that we'll go over that next Monday. And if, I've never really had an issue because we always I know we have that Monday and I feel bad interrupting her to like, have her stop what she's doing to help me so I'm like, Okay, this is well, just let you know, this is what I want to go over on Monday and stuff like that.

Tutoring Previous Experiences – Statements that deal with any prior tutoring that the tutee may have had. This is not specific to chemistry, it can be any kind of tutoring at any point in their educational career.

• I was tutored in algebra two, pre-calculus and chemistry as a matter of fact. So um, I had one tutor for -- there's this place in my hometown that's like, known for just really good tutors. And there's just like two guys that are just really good at explaining things. Everybody goes there.

6.6 Tutor – Tutee Relationship Codes

Caring – Statements that focus on how the tutee feels that their tutor is caring towards them and how this affects tutoring.

• And when you build those personal relationships, those these people start to care about like that you understand it, they start to care about like, and professors don't really provide that anymore. They're just want to get the videos out and be done with it. So it's nice to have that connection again with a person of more intelligence than me.

Comfortable – Statements from the tutee that focus on being comfortable with the tutor and how

this has changed over time or affects the tutoring experience.

• Yeah, she was very easy to get along with. She was like, around the same age that I was, she wasn't too much older than me. So it was easy just to ask a question or to ask her to repeat something. And I never felt like she was judging by any means. Like she was just very, it was very casual.

Not Alone – Statements that highlight the importance of not feeling alone with the struggles of chemistry and how the tutoring relationship provides this.

• Because at the beginning, I didn't have one I was like, I must be just me because no one else seems to be struggling as much as I am. But when I like, tell her my frustration, she's like, I get it. Like I've done the same thing before you're not alone. So it helps like, make me feel better that I'm not an idiot.

Power Dynamic – Statements that deal with the power dynamic in the relationship, specifically where the power resides.

• I think it's helpful for the tutor to have a little bit more control, because they're the ones teaching and they need to feel confident in their teaching. So if the student were to have more control, they might be unsure of what they're saying a little more. So I think it's important for the tutor to kind of be in the lead.

Trust – Statements that discuss trust between the tutor and tutee, how this affects the relationship between the two, and how it affects the tutoring experience.

• And I think the first tutoring session, I might have been like a little doubtful, or just kind of trying to understand and stick with it for a little bit. But the second one, I was kind of just like a bit questiony where I was like, like, "I could be doing this on my own if I wanted to." But then I realized that she goes in depth when she talks about each slide, she's not just reading it off, but it took me at least one full session to get to that point.

Understanding – Statements that show how the tutor is understanding of what the tutee needs and says and how this affects their relationship and the tutoring experience.

• Yeah. Because that's exactly what I was asking. I didn't know what to look at. I was just looking at a structure instead of trying to understand what specifically I was looking at. And she made it very clear that like, oh, you're really only looking at the bottom group because the other structures are always going to be there.

6.7 Tutoring Moves

Asking for Help – Instances wherein the tutee explicitly asks for help or discussions of those instances.

• Okay, so how would we start this? Do we just figure out if this is polar or nonpolar?

Breakdown – Instances wherein the tutor takes a complicated concept or task and attempts to break it down into simpler concepts or tasks.

• For me, I've always been the person that like, if you just flat out tell me something, I have to know the back reasons for it. Like the reasons behind it. So when she'd be like, okay, this is telling you this. So like, if you break for me, it had to be broken down into steps to fully understand the concept. And I think she really understood that.

Call Back – Instances in which the tutor mentions specific previous topics they have covered together in order to help the tutee understand what they are currently talking about.

• [S]o when something is strong electrolyte, that means like, I don't know, if you remember when we talked about like strong acids? And how, like, if you have a strong acid, it like dissociates completely strong acid is the same as a strong electro electrolyte in the lecture, like also dissociated completely.

Change the Question – Instances where the tutor creates a different question from the one presented in order to help make the topic of the question make more sense.

• Rank these molecules for most to least soluble in, let's say, hexane. It's hexane is nonpolar, right? So what would be most soluble in something like hexane something that's nonpolar?
Lecturing – Instances where the tutor is going through concepts and instructing the tutee with little to no interaction occurring.

• We just, what she would do is pull up the PowerPoint from the previous week and we'd just run through the PowerPoint. And we'd just focus on different parts of, we're really focused on like all of it at the same length. But if I had a question we'd like stick around longer.

Making Connections – Instances in which the tutor connects one topic or question to another topic or question without the specific mention of how they worked on it previously, thus differentiating it from "Call Back."

• I have a hard time sorting concepts in my head when it comes down to like, categories, subcategories, so I don't, I have a hard time differentiating what is like the bigger category and what falls underneath that category, and this is a different category that's similar to this one, I can't connect that, everything is just very separate.

Repetition – Instances in which the tutor repeats a point or topic in order to help the tutee understand the thing being repeated better. Can include doing the same type of question again or mentions of how repetition is important to learning.

• Okay, I'm getting like, this is what we need and this is like, so that was the first problem we did. So I was like, okaaayyyy, but then as the tutoring went along, it was getting more and more clear, because she kept just, it helps that she kept saying the same thing. So it started like, really being hammered in.

Scaffolding – Instances in which the tutor walks the tutee through the steps of a problem while

prompting the tutee to lead themselves through the problem with the questions the tutor asks.

• She can help me like she like give me a stepping stone. But she's not going to solve it all the way for me, she just kind of like, sets me on the right path. So like when she gives me problems like this, even when I'm not necessarily fully understanding it. Like if I'm not understanding the concept that well and she gives me a problem to solve, and I can say, I don't know how to start. When she like gives me somewhere to start, it kind of like helps me learn as I do the problem.

Sense Making Check – Instances where the tutor stops the flow of the tutoring session to make sure the tutee understands what is being covered at that moment.

• Yeah, like, whenever you finish, like a concept with her like little whiteboard thing, she always is like, "does that make sense? Or do you want to do a few more problems?" So I feel like that's just consistently something she does, which was really nice in the beginning, if I was like, kind of nervous to be like, "I don't really get this that much." It was easy with her. Like, instead of her just saying, "are you good to move forward?" And it's kind of hard to say, "no, I'm kind of still confused," like in the first, when you're first talking to somebody. So when she automatically offers up like, "do you want to do more?" It's easier to say yes to that. So it was really nice in the beginning when she would do that.

Step 4 – The fourth step of the tutoring frame wherein the tutor and tutee co-construct knowledge in order to address a shown lack of understanding on the tutee's part.

- Tutor: So yeah, so then what structure would this be? What type of structure?
- Tutee: Oh, I don't know, is it it's either tertiary or quaternary, maybe?
- Tutor: So the quaternary one is when there's more than one.
- Tutee: Yeah.
- Tutor: Um, but here this there's only one, right?
- Tutee: Yeah.
- Tutor: So there's only one here. Um, so it wouldn't be that one. And tertiary is going to be something that's already pretty folded up. When you see something like this, like, when you see something that has this, like helical shape, it's going to be like an alpha helix. And that's always going to refer to a secondary structure.

Step 5 – The fifth step of the tutoring frame in which the tutor evaluates the new knowledge that the tutee now has after step 4 in order to make sure that step 4 was successful.

- Tutor: Um, yes. So does that kind of make sense for differentiating non polar, polar, or ionic? Or do you feel like we should go through a few more examples?
- Tutee: No, that makes sense.
- Tutor: Okay. All right.

Understanding Why – Instances in which the tutee asks for or the tutor provides justification either for the way that things are connected or why certain topics are worth learning.

• When I would ask her about, like, the breakdown of stuff, she knew it and like, I could tell that like, she was more real with me, I'm like, do I need to know this? And she's like, no, but it's gonna help you with other concepts along the way. So I was like Okay that makes sense why I need to dive deeper into this. So it helps me further along.

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LIST OF PUBLICATIONS

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