STUDENT EXPERIENCES AND MOTIVATIONS IN A FLIPPED GENERAL CHEMISTRY II COURSE

by

Elijah B. Roth

A Dissertation

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Doctor of Philosophy
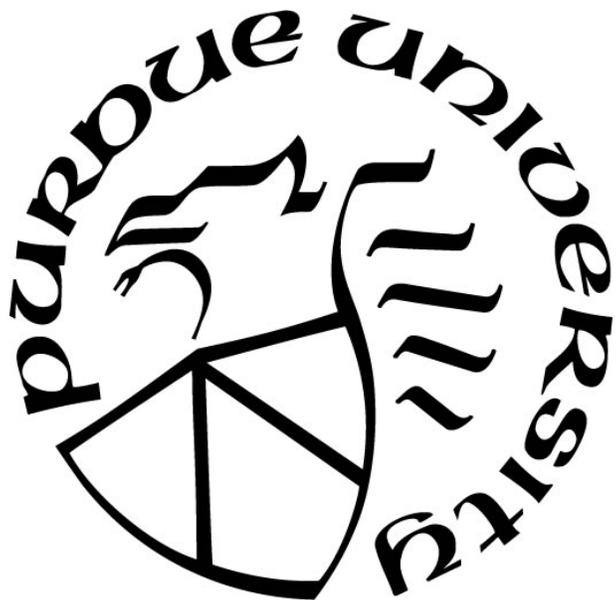
Department of Chemistry

West Lafayette, Indiana

August 2020

THE PURDUE UNIVERSITY GRADUATE SCHOOL
STATEMENT OF COMMITTEE APPROVAL

Dr. George Bodner, Co-Chair

Department of Chemistry

Dr. Roy Tasker, Co-Chair

School of Science, Western Sydney University

Dr. Helen Patrick

Department of Educational Studies

Dr. Adam Wasserman

Department of Chemistry

Approved by:

Dr. Christine Hrycyna

Dedicated to the champions of learning in my life: Zayde (Dr. Gilbert Roth, D.O.) and Grandpa

Paul Jon Zischka

ACKNOWLEDGMENTS

For the rest of this section, I would like to acknowledge the individuals who have invested in my development and thank them for their persistent encouragement and influence throughout the journey that has brought me to this point.

First, I would like to acknowledge my family. To my mother, for her love and encouragement when things seemed to only be going wrong. You have been a beacon of joy and positivity throughout my life and I would not have made it this far without your optimism spurring me on. To my father, for his constant cognitive challenges. Even when I was a child you challenged my thinking, maybe more for your own amusement than my development, but I believe that the results of these challenges have made me the critical thinker that I am today. You helped instill a passion for the natural world and an interest in why things work the way they do, spurring on my curiosity and encouraging my interests in science. To my sister, for igniting my interest in other human beings. Your creativity and imagination brought vivacity into my personality and a recognition of the way others think. I blame you for the fact that I have chosen this path for my research and career…thank you?

To my grandparents. First, to Bubbe, for your love and wisdom. When things went wrong, I heard your voice saying "chickaboom," and I would get back to work with a smile knowing that if this was the worst that was happening, I guess I had it pretty good. You and Zayde always encouraged us grandchildren to pursue our education, and reminded us that education was one thing that no one could take away from us. You both would ask for our report cards, even in college and would post them on the refrigerator door, modeling what was valued in our family. To Grandpa Althoff, for your model of optimism. I admire the way you are able to see the world and live each day expecting and assuming the best of those around you. This natural preemptive mercy and grace is so rare and I am thankful to have you as a model that I can use to apply this to my own life. Finally to my late Grandpa Paul and Zayde, mentioned above. These two men were the epitome of learning in my life. As I mentioned in my address to Bubbe, Zayde showed us grandchildren

how to value education. He worked hard to become a doctor and run a medical practice and never stopped learning until the day he died. Grandpa Paul was a man who loved knowledge too, but he also embraced play. He made sure to pour into his great grandchildren making sure they felt loved by playing with toy cars and in blanket forts, while sharing his wealthy of knowledge about the world and his passion for history.

To my girlfriend, Victoria, for your patience, encouragement, and advice. There is no way I would have survived these last few months without you. Thank you for patiently bearing with me through my forgetfulness, scattered mind, and emotional moments. Thank you for your encouragement when imposter syndrome set in and for walking with me to the finish line. I am so eager to see how you continue to move through graduate school. You are absolutely brilliant, but humble; gentle, yet fierce. I admire that in you, and love you more for it.

To my friends back home. To Chase and Emily for your faith in me and encouragement. As much as you joked about me "giving up and coming home," I knew that you would not let me do that. Chase, your mind is an incredible entity. Your interests run deep and wide, and it has been my honor to call you one of my closest friends. I love that we can discuss almost anything and have those conversations in depth. Emily, your strength is inspiring. When I think of you, the terms "force of nature" and "mountain mover" come to mind. You carry yourself with a sense of pride that no one can topple and am always in awe at the way you lead those around you. Thank you for choosing us weirdos to be your friends. I know that you have brought so much strength into my life, by simply being a model of it. To Sean for prompting me to grow throughout middle school, high school, and up to the present. You challenge my way of thinking and acting, and have helped me to come out of my shell and have fun. I love how you seem to have no inhibitions. You are who you are, and there is nothing that anyone could do to make you change. You are my oldest and one of my dearest friends and I cannot say enough about what you have meant to me. To Alfredo, for more than I can say. You have been someone that I could call anytime during these past five years. You have flown out simply to comfort me during tough times. You are there for me no matter what. You have chosen to become part of my family and there is nothing that I can say to do justice to what your friendship means to me. I am left speechless with "thank you," as the only thing that I can say.

To my mentors, Dr. Steve Pauls and Nick Bradley. Steve (yes, it still feels weird calling you by your first name, even though I have been calling you that for five years now), from our first

conversation, I could sense what you described as a "kindred spirit" between us. From discussions of physics and chemistry to students' loci of control and Piaget, I started moving towards educational research early on without even knowing it. Thank you for the role you have played in my development as a chemical educator and scientist. I am so excited to begin collaborating with you soon. Nick, your fascination for the natural world and the supernatural world helped me to further embrace my faith in middle school. Since then our chats about religion, science, and life have been a biannual event that I have looked forward to during every visit over these past five years. I am eager for more frequent conversations now that I will be closer.

To the congregation at Riverside Covenant Church, for the family that they have provided to a sojourner in their midst. I could not have imagined how much of an impression Riverside would leave on me when I began attending. Each person that I have had the pleasure of knowing could contribute to a whole new dissertation on the power of kindness. Thank you for welcoming me, embracing me, and supporting me through each of the hurdles that life has thrown at me over the past five years. By the grace of God, acting through the willing vessels at Riverside, I have had the pleasure of seeing my Lord at work. I must also acknowledge my Lord and Savior, for His grace and gifts that have brought me to this point. I owe it all to Him and His mercy. My Father in Heaven who has given me the strength and direction to pursue this goal. I am eager to see how I can best serve Him with this experience in the next chapter of my life.

To the Taskernauts, past and present. I could not have imagined the impression that each of you would leave on me during our time together. To Jared, for your overwhelming optimism. We started this journey together in 2015 and now we are both doctors. Crazy! It was an honor working alongside you and having the opportunity to craft our research styles together. I have missed your dad jokes, but am thankful that you still send the "good ones" my way when you think of me. To Ashton, for encouraging and challenging me to be better mentally and physically. I will always cherish our workout sessions. I need to get into a routine at my next job, but I know that it will not be as motivating without the laughter of you and our friends. Thank you for your genuinely kind and encouraging personality. To Kevin, the last of the remaining Taskernauts, I have truly enjoyed these past months of sharing a space with you. Your unapologetic vitality brought life into a space where people kept leaving. I loved the "Kevinisms" (ya-huh) (thank you Ashton for the term), that you have become known for. I even find myself saying them sometimes. You are an incredible researcher and I am so excited to see where these projects take you. To Ashley, a former

Taskernaut (but once a Taskernaut always a Taskernaut), thank you for sharing a garden with me every summer. It has been one of the highlights of my years. You have such a kind and tender heart, always eager to help anyone. Thank you for ALL of your help during the last few pieces of this project and for helping me with the revisions as well. You were truly invaluable. To Stephanie, my mentee and another former Taskernaut, thank you for your zeal. You have a fervor that constantly inspires me and I hope that I can take a fraction of that ardor with me as I begin my career as a faculty member. I have learned so much from you as a model of strength and perseverance. To Chris, my roomie and Bachelor Bro. What can be said? Thank you for your encouragement in the middle of the night when I was freaking out about upcoming meetings and projects; for staying up with me to talk through the chaos that I had put together and talking through it until it was coherent; for advising and mentoring me through the development of my methodology and my own research style. You were truly instrumental during this journey, not only as a colleague and advisor, but as a dear friend. As with all of the Taskernauts mentioned above, and the ChemEd family mentioned below, I am eager to see how our friendship blooms in new ways with the new adventures that we are all embarking on.

To various members of my ChemEd family. To Franziska, for her support and the opportunities that she paved the way for me to embrace. It was an absolute honor and pleasure to develop the TA training course and the sophomore seminar. I am looking forward to our future collaborations. To Stefan, my mentor, for the model of calm in the midst of graduate school. I know you (or someone close to you) described your demeanor as a duck in the water; calm on top but your feet are kicking like crazy underneath. Even if you were just keeping the chaos under the surface, in my eyes you served as a reminder that things will be okay. There is no use worrying. To Kathleen, Princess Mischief, my TA partner, and my workout buddy, for your challenges, support, and all of the fun we had teaching P. Chem. Your questions have prepared me for this next adventure at Azusa Pacific University. Thank you for the deep and exciting conversations as well as the ridiculous banter. You truly earn your title.

To my committee members, Helen and Adam, thank you for your direction during various aspects of this project. You each contributed in ways I did not originally anticipate when I chose you for my committee, but I valued every nugget that you provided me.

Finally to my advisors, Roy and George, for your passion, mentorship, and belief in me. I learned so much from each of you about passion in research, teaching, and relationships. Roy,

thank you for your charisma. If I could take a fragment of your energy into my classroom, I know that I will have my students on the edge of their seats. I know I was whenever I listened to your presentations; even when you introduced speakers for our seminars I felt like something exciting was about to happen. George, thank you for the conversations about anything from music to cars to philosophy to theatre and sometimes chemistry and education. I am eager to take some of the lessons that I learned from you about the history of physical chemistry and incorporate them into my own teaching.

I wish that I could take the time to express my gratitude for each individual who left their impression on me during this time, but that would fill tomes that we simply do not have the space or time for. I feel that I have not even done justice to the influences of those who I have acknowledged above. With that I leave you all with a thank you and God bless you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Student-centered pedagogies have become increasingly popular in higher education. Research on flipped learning, in particular, has shown that collaborative problem-solving environments are able to better support effective learning than lecture alone. However, the effects of this format on students' interests and motivations in chemistry remain unknown. For this study, students and graduate teaching assistants who participated in a flipped learning, second-semester general chemistry course were selected to participate in a focus group discussion and individual interviews that explored their experiences and perceptions of the features of the course (affordances) that supported and thwarted their sense of motivation.

This phenomenographic study mapped eight students' experiences of the course and used qualitative data from interviews with the graduate teaching assistants (TAs) to compare and contrast with students' claims. Self-determination theory was used to frame these experiences and the results were discussed using other relevant theories of motivation, including, but not limited to expectancy-value theory and achievement goal theories.

It was found that there are several features of the course that support students' motivations according to the basic psychological needs of relatedness, autonomy, and competency in self-determination theory. The study also revealed many features of the course that thwarted students' motivations. Features that students described as motivating left them feeling connected to their peers and other agents in the course, capable of efficiently interacting with their environments as a result of the course tasks, and a sense that their performance was related to their efforts. Features that students' described as demotivating left them feeling helpless, incompetent, alone, and without a sense of control over their performance in the course.

The results of this study shed light on students' perceptions of the environment in a flipped learning chemistry course. These findings can be used to improve students' experiences, and consequently their motivation when taking a flipped learning chemistry course. Specific assertions developed from these results and recommendations for these improvements are further discussed.

CHAPTER 1.   INTRODUCTION

Student attitudes toward chemistry generally progress from "I can't understand" to "I shall never understand," and finally to "I don't care if I understand," (Johnstone, 2010). Mahaffy et al. (2014) explained that students "find the discipline irrelevant, uninteresting, and indigestible." Research in the role of motivation in learning has shown that motivation has an influence over various aspects of how students learn (Pintrich, 2003; Schunk, Meece, & Pintrich, 2014). Environments that provoke the sensations described by Mahaffy et al. (2014) and Johnstone (2010) risk fostering student behaviors that lead away from learning (Koestner & Losier, 2002; Vallerand & Ratelle, 2002).

The importance of motivation for learning in any course is undeniable (Dweck, 1986; Zusho, Pintrich, & Coppola, 2003; Koestner & Losier, 2002; Vallerand & Ratelle, 2002). There has been some research that has probed student motivation in general chemistry (e.g., Ferrell, Phillips, & Barbera, 2016), organic chemistry (e.g., Austin, Hammond, Barrows, Gould, & Gould, 2018), and chemistry laboratory courses (e.g., DeKorver & Towns, 2015). However, if we want to create an educational environment where students can have an enjoyable and exciting experience, we must understand what that means *for* students. This specifically involves understanding the students' experiences in the course, particularly in flipped learning environments.

In the context of this study, "flipped learning" is defined as learning that is accomplished by students reviewing lecture material outside of the scheduled class session and engaging in collaborative activities with other students during the normally scheduled class session. The details of how this was executed are discussed in later chapters.

Recent studies on flipped learning in general chemistry suggest a need to understand the source of students' perceptions of the course and recommend a qualitative approach for exploring the nuances of these perspectives (Seery, 2015; Sturtevant, 2016). As blended learning pedagogies (flipped learning in particular) become more prevalent in the chemistry classroom, it is important to catalog the effects that it can have on a students' interests in learning chemistry. This study expands Sturtevant's (2016) research in order to explore some of those nuances mentioned by Seery (2015), through a phenomenographic investigation of student and TA perceptions of a second-semester, flipped general chemistry course.

1.1   Purpose of this Study

It is important to understand the social contexts and motivational regulators that influence motivation in general chemistry courses because students perform better and process material at a deeper level when they are more engaged, which is a consequence of more internalized motivational regulation (Koestner & Losier, 2002; Vallerand & Ratelle, 2002). The goal of this research is to better understand the experiences of students taking a flipped second-semester general chemistry course. The overarching research question is to understand how the affordances in a flipped second-semester general chemistry course affect to students' motivation.

A phenomenographic framework was adopted, where the researcher investigated the way individuals experienced a given phenomenon; motivation (Orgill, 2007). Self-determination theory was used to inform the data collection methods and frame the results.

1.2   Research Questions

This project was developed as a way to understand how the affordances in a flipped second-semester general chemistry course relate to students' motivation. The specific research questions are as follows:

- What affordances were present in the course that influenced students' motivations?
- How did the affordances in the course support or thwart students' motivations?
- What affordances should there have been to support students' motivations?

The study addresses these questions by collecting data from students and TAs through individual interviews, focus groups discussions, and a course evaluation.

1.3   Overview of Chapters

Previous research on flipped learning in chemistry, as well as student motivation in chemistry are considered in the literature review in Chapter 2. An overview of student motivation and engagement, and the history of self-determination theory will be presented. A general review of research in college student motivation will also be discussed. Chapter 3 will describe the methodologies employed for data collection and analysis, as well as the context and limitations of

the study. Selected quotes from students and TAs are presented in Chapters 4, 5, and 6. These chapters will be limited to the definitions of the themes and categories developed from the research and corresponding excerpts of data. Quotes that highlight students' emotions and reflections during the course will be presented in Chapter 4 and quotes about the influence of different relationships on the students' perceptions of the course will be presented in Chapter 5. Finally, quotes addressing students' recognitions of how the course was designed to work as well as their perceptions of different events in the course will be presented in Chapter 6. All of these results will be expounded upon in Chapter 7 along with assertions about what they mean. Chapter 8 will describe the conclusions and recommendations based on the findings of this study.

1.4   References

Austin, A. C., Hammond, N. B., Barrows, N., Gould, D. L., and Gould, I. R. (2018). Relating motivation and student outcomes in general organic chemistry. *Chem. Educ. Res. Pract., 19,* 331-341.

DeKorver, B. K. and Towns, M. H. (2015). General chemistry students' goals for chemistry laboratory coursework. *J. Chem. Ed., 92,* 2031-2037.

Dweck C. S., (1986), Motivational Processes Affecting Learning, *American Psychologist, 41*(10), 1040–1048.

Ferrell B., Phillips M. M., and Barbera J. (2016). Connecting achievement motivation to performance in general chemistry, *Chem. Educ. Res. Pract., 17*, 1054–1066.

Johnstone, A. H. (2010). You Can't Get There from Here. *Journal of Chemical Education, 87*, 22-29.

Koestner, R., and Losier, G. F. (2002). 5: Distinguishing three ways of being internally motivated: A closer look at introjection, identification and intrinsic motivation. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (101-121). Rochester, NY: The University of Rochester Press.

Mahaffy, P. G., Martin, B. E., Kirchhoff, M., McKenzie, L., Holme, T., Versprille, A., & Towns, M. (2014). Infusing Sustainability Science Literacy through Chemistry Education: Climate Science as a Rich Context for Learning Chemistry. *ACS Sustainable Chemistry & Engineering, 2,* 2488-2494. http://dx.doi.org/10.1021/sc500415k

Orgill, M. (2007). Phenomenography. In G. M. Bodner & M. Orgill (Eds.), *Theoretical frameworks for research in chemistry/science education* (127-145). Upper Saddle River, NJ: Pearson.

Pintrich P. R., (2003), A motivational science perspective on the role of student motivation in learning and teaching contexts, *Journal of Educational Psychology, 95*(4), 667–686.

Schunk, D. H., Meece, J. L. and Pintrich, P. R. (Eds.). (2014). *Motivation in education: Theory, research, and applications* (4th edition). Indianapolis: Pearson.

Seery, M. K. (2015). Flipped learning in higher education chemistry: emerging trends and potential directions. *Chemistry Education Research and Practice*, *16*(4), 758–768.

Sturtevant, H. G. (2016). *Design, implementation, and evaluation of a hybrid scale-up model for general chemistry courses.* Purdue University, West Lafayette, IN.

Vallerand, R. J. and Ratelle, C. F. (2002). 2: Intrinsic and extrinsic motivation: A hierarchical model. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (37-63). Rochester, NY: The University of Rochester Press.

Zusho, A., Pintrich, P. R., and Coppola, B. (2003) Skill and will: The role of motivation and cognition in the learning of college chemistry. *Int. J. Sci. Educ., 25*(9), 1081–1094.

CHAPTER 2.   LITERATURE REVIEW

2.1   Student Motivation & Engagement

The term "motivation" in general is a multifaceted concept (Pintrich, 1999) that includes ideas relating to persistence, task commitment, intrinsic or extrinsic interest, the desire to learn, and the drive to succeed (Friedman-Nimz & Skyba, 2009). Deriving from the Latin word *movere* (to move), the term *motivate* has been defined by Ryan and Deci (2000), simply as, "to be moved to do something" (p. 54). In David Myer's (2011) introductory psychology book, *Exploring Psychology,* motivation is defined as a need or desire that energizes and directs behavior. Ben-Eliyahu, Moore, Dorph, and Schunn (2018) differentiate motivation from engagement, which is defined as the "intensity of productive involvement with an activity" (p. 87), whereas motivation is a "pre-existing learner characteristic that produces engagement" (p. 88). Essentially, Ben-Eliyahu et al. (2018) explain that before one is able to *engage* with learning, there needs to be a desire (*motivation*) to learn. In other words, motivation instigates engagement.

A cornucopia of theories has been developed to explain human motivation from different perspectives. In this study, Deci's and Ryan's (1985) self-determination theory is used to study the perceptions, experiences, and motivations of students taking general chemistry.

2.1.1   Self-Determination Theory (SDT)

Self-determination theory is a meta-theory of six sub-theories that explain numerous factors that make up and influence human motivation. Its founders, Deci and Ryan (1985), studied how to promote environments that best support growth tendencies and psychological needs. Their work built upon previous motivational research (Baumeister & Leary, 1995; deCharms, 1968; Reis, 1994; White, 1963), by focusing on three basic psychological needs: autonomy, relatedness, and competence (Ryan & Deci, 2000). These terms will be further outlined below.

These basic psychological needs are influenced by the social contexts in which individuals are placed, such as in a classroom (Vallerand & Ratelle, 2002). It is important to note here that it is not the *actual* influence of the social factors, but an individual's *interpretation* of the context in which these social factors impact their basic psychological needs that is important (Wild & Enzle,

2002). Based on whether these basic psychological needs are supported influences what type of motivation an individual will experience, which in turn promotes what level of engagement they will participate at. This relationship is illustrated in Figure 2.1.
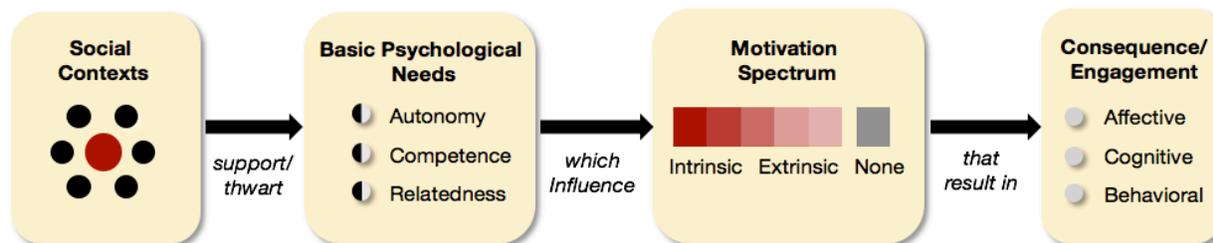
Figure 2.1. This figure depicts the relationship between social contexts, basic psychological needs, types of motivations, and levels of engagement. Social contexts support or thwart the basic psychological needs of autonomy, competence, and relatedness. These influence what type of motivation is experienced, and result in a level of affective, cognitive, and/or behavioral engagement.

2.1.1.1   The SDT Continuum

Self-determination theory is unique from other motivational theories because it recognizes different levels and orientations of motivation, rather than proposing it as a dichotomous construct (Ryan & Deci, 2000). Distinct levels of motivation can be characterized by diverse types of regulators along a continuum, according to self-determination theory (see Table 2.1). In this theory, there are three general forms of motivation: intrinsic motivation, extrinsic motivation, and amotivation. The most internal form of motivation is intrinsic motivation, which is based on an inherent satisfaction, inseparable from participation in the activity itself (Ben-Eliyahu et al., 2018). Intrinsic motivation is characterized by an innate energy experienced when one pursues a goal or activity, because it is fun or interesting, and manifests itself as curiosity, the pursuit of a stimulating challenge, or an opportunity to develop/display competence (Koestner & Losier, 2002). According to Vallerand and Ratelle (2002), intrinsic motivation can be experienced in the inherent pleasure gained from the process of learning/exploring, the process of creating/accomplishing something, and the process of stimulating individual senses associated with the activity. These are generally categorized as an intrinsic motivation *to know, to accomplish,* and *to experience stimulation*, respectively. Intrinsic motivation is always identified with an internal locus of causality and

satisfying the need for competence (Vallerand & Ratelle, 2002). Simply put, intrinsic motivation is associated with the satisfaction inherent to the *process* of performing the activity and independent of any separable outcomes of the activity.

On the other end of the motivation spectrum, is amotivation, defined as "lacking the intention to act" (Ryan & Deci, 2002, p. 17). Amotivation is characterized by inaction or passive action. Vallerand and Ratelle (2002) relate amotivation to learned helplessness, highlighting its dependence on competence and autonomy. When an individual repeatedly feels that they are incompetent at something and lack the power to overcome that incompetence, they develop the belief that they have no control over the outcome (Ulusoy & Duy, 2013). This "learned helplessness" can lead to less and less effort towards an actively ultimately ending in a desire to resign from engagement with the activity entirely (amotivation) (Teodorescu & Erev, 2014). Amotivation is manifested in little effort being put into an activity such as learning, and even the potential to quit the activity entirely. Essentially, amotivation has detrimental consequences for performance with respect to education in particular.

Table 2.1. The SDT Continuum. This table illustrates the different levels of motivation and how they are regulated according to self-determination theory.

Intrinsic Motivation	Extrinsic Motivation				Amotivation
	Integrated Regulation	*Identified Regulation*	*Introjected Regulation*	*External Regulation*	
Involves inherent satisfaction in the activity, inseparable from the activity itself	Part of who one is; Regulation integrated with personal values, goals, and needs	Consciously values activity as important	Internalization of an external regulation; Done to avoid feelings of shame or attain self-worth; Controlled by ego	Done to achieve rewards or avoid punishment; Response to a demand	Lacking intent to act; No action/ passive action; Going through the motions

In between these two general types of motivation is extrinsic motivation, which is regulated by outcomes that are separable from the activity itself. While many define extrinsic motivation as the antithesis of intrinsic motivation, in the sense that intrinsic motivation is characterized by autonomous behavior and therefore extrinsic motivation must be characterized by non-autonomous behavior, it is possible for someone to be autonomously, extrinsically motivated (Ryan & Deci, 2002). In other words, one can be propelled into action as a result of external stimuli alone, or they can willingly perform a task in a manner that reflects their inner acceptance of the value or utility of that task (Ryan & Deci, 2000).

Ryan and Deci (2002) define a spectrum of four types of regulations for extrinsic motivation between intrinsic and amotivation. The least autonomous form of extrinsic motivation is external regulation. Motivation in external regulation is characterized by a response to an external demand to attain a positive end (reward) or avoid a negative end (punishment) (Ryan & Deci, 2002). There is an external control imposed by the external demand, no pursuit of competence, and only the *potential* for relatedness.

As an external regulation becomes more internalized, it becomes an introjected regulation. Ryan and Deci (2002) explain that introjected regulation is no longer governed by external rewards or punishment, but internal obligations to avoid shame and guilt or attain ego enhancements and self-worth. The individual does not face external pressures to perform, but internal pressures to maintain their self-esteem. This is referred to as "ego-involved activity" and results in perceptions of an external locus of causality, despite its internal nature (Ryan & Deci, 2002). Essentially, introjected regulation can be characterized by motivation resulting from a sense of duty. The individual is not required to do something, but they feel as though they should, whether they believe in it or not.

While introjected regulation does not accept an activity as necessarily important, identified regulation recognize the value of an activity and its relevance to their life. Identified regulation involves a conscious valuing of a goal and the activities necessary for achieving it (Ryan & Deci, 2002). This "conscious valuing" is indicative of a higher level of perceived autonomy and a movement towards a more internal locus of causality. Behaviors are accepted as personally important but are compartmentalized as a means to an end. Simply put, identified regulation recognizes the value of an activity and pursues that activity as long as it is useful.

Finally, the most internalized and autonomous form of extrinsic motivation is integrated regulation. This form of motivation is completely integrated with an individual's personal values, goals, and needs and is considered a part of the individual (Ryan & Deci, 2002). In integrated regulation, activities are performed out of one's own volition. While integrated regulation is completely internalized, it remains a form of extrinsic motivation, because it is still done to attain an outcome that is separable from the activity, and not because of the individual's inherent interest (Ryan & Deci, 2002). Integrated regulation may not involve enjoyment in an activity, but the activity is performed because it is in line with an individual's identity.

It can be seen from these forms of extrinsic motivation, that internalization is a continuum that spans from well-integrated regulations of autonomous, extrinsic motivation to less internalized, controlled forms of extrinsic motivation. These types of motivation are not necessarily achieved in a progressive manner, but can be adopted spontaneously depending on pre-existing interests, values, and identities (Vallerand & Ratelle, 2002).

2.1.1.1.1   Examples of the Continuum Applied to Chemistry Students

In the hope of summarizing and clarifying the different types of motivations, examples have been provided. In externally regulated motivation, students may feel compelled to do well on an assignment in order to achieve good grades and avoid admonishment from parents. In introjected regulation, a student will participate in an academic task in order to avoid a sense of shame or to feel proud. An individual who has identified regulation to do well in class, recognizes the benefits that are gained in understanding the material despite her distaste for the activity itself. An honors student, who hates chemistry, but continues to actively participate and do well because he identifies as an honors student and "that is simply what they do", demonstrates integrated regulation. Finally, a student who is intrinsically motivated to learn chemistry participates simply for the inherent joy achieved in the process of learning. Specific examples of what a student might say about how they participate in chemistry based on the type of motivation they experience can be found in Table 2.2.

2.1.1.2 Basic Psychological Needs

These levels of motivation are influenced by the degree to which social contexts support or thwart students' basic psychological needs; competence, relatedness, and autonomy (Vansteenkiste, Lens, & Deci, 2006). This influence can be seen in Figure 2.1 Findings from studies on the effect of need satisfaction on motivation in educational settings generally concur with SDT in that need satisfaction has adaptive consequences. For example, presenting tasks consistent with satisfaction of basic psychological needs was shown to lead to positive learning outcomes such as better performance and deeper processing (Vansteenkiste, Simons, Lens, Sheldon & Deci, 2004).

Table 2.2. Motivation examples from chemistry. This table provides specific examples of what a student might say about how they participate in chemistry based on the type of motivation they experience.

Intrinsic Motivation	Extrinsic Motivation				Amotivation
	Integrated Regulation	*Identified Regulation*	*Introjected Regulation*	*External Regulation*	
I participate in chemistry because I think it is fun to discover new ways of seeing the world	I participate in chemistry because I am a good student	I participate in chemistry because the concepts I am learning can be used in my career later on	I participate in chemistry because people would think poorly of me if I didn't do well	I participate in chemistry because I want to get a good grade in the course	I don't participate in chemistry

The first basic psychological need is the *need for competence,* which is defined as the need to efficiently interact with one's own environment and produce desired outcomes (Vallerand & Ratelle, 2002). Successful progression through an activity and positive feedback can increase an individual's perceived competence, thereby promoting greater internalization of regulators associated with that activity (Ryan & Deci, 2002). Even the *prospect* of gaining competence has the potential to influence one's motivation. An activity that has the opportunity for an individual to achieve effective and efficient results has the potential to overcome the uninteresting and

unenjoyable process of the activity itself, thereby promoting greater internalization of the regulator. An example of competence support in a chemistry course, could include demonstrating why vinegar can be used to clean calcium deposits left in a boiling pan rather than just lecturing on the reduction potentials of calcium and hydrogen.

The *need for relatedness* is defined as a need to feel connected or a part of something greater than oneself (Vallerand & Ratelle, 2002). Evidence in Baumeister and Leary's (1995) review of empirical literature related to the need to belong suggests that the need for relatedness is a powerful, fundamental, and extremely pervasive source of motivation. An activity that provides opportunities for individuals to associate and be a part of a larger group or community has the potential to promote greater internalization of a regulator associated with that activity. An example of relatedness support in a chemistry course, could include walking around the lab and asking students about their majors and what they intend to do with them, rather than sitting at the front and begrudgingly getting up to answer their questions.

Finally, one of the most influential basic psychological needs with respect to self-determination theory is the *need for autonomy*. This need is defined as a "desire to be the origin of one's own behavior" (Vallerand & Ratelle, 2002, p. 48). This is characterized by an individual's perceived *locus of causality.* According to Ryan and Deci, volitional behavior that originates from the individual, has an internally perceived locus of causality, while forced behavior that originates from pressures on the individual has an externally perceived locus of causality (2002). By providing choices of what to do or how to do it, one can enhance another's perceived autonomy, thus promoting greater internalization of regulators. However, threats of punishment, deadlines, imposed goals, surveillance, competition, and evaluation all have the potential to act as external controls, undermining internalized regulators (Ryan & Deci, 2002). Even "ego-involved activities" that result in enhanced self-esteem or guilt, have a greater focus on the functional significance of the task, which despite its internal origin, can be perceived as controlling and a more external locus of causality (Ryan & Deci, 2002). An example of autonomy support in a chemistry course, could include using invitational language that encourages students to choose to participate in the use of spectrophotometry to measure the concentration of iron in broccoli or the mass of copper in pennies, rather than requiring that students follow a set of procedures that limit their options in an experiment.

In education, extensive research has been guided by SDT (e.g., Reeve, Jang, Carrell, Jeon, & Barch, 2004; Black and Deci, 2000; Lepper & Henderlong, 2000; Su & Reeve, 2011; Reeve, 2012; Vaino, Holbrook, & Rannikmae, 2012; Lynch & Tujillo, 2010). Studies have shown that students who report autonomous motivation experience increased creativity and retention of material, along with higher academic achievement and self-worth (Reeve, 2002). Work on needs-supportive teaching styles suggest that teachers who support autonomy by listening, allowing time for independent work, and asking questions about what they want to do as they teach, enhance students' intrinsic motivation and internalization (Reeve, Bolt, & Cai, 1999). (It should be noted that the literature refers to this style of teaching as "autonomy-supportive," however, I believe "needs-supportive" is a more appropriate term since the style addresses the satisfaction of *all* psychological needs, and not just autonomy). These findings are further supported by research which suggests that promoting class interactions, providing supportive feedback, and adopting clear goals that emphasize learning over grades increase intrinsic motivation and the use of self-regulated learning strategies (Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009). More recently, Moos and Honkomp (2011) reported a mixed-method study highlighting the beneficial effects of "adventure learning" by showing that the motivation components of the Motivated Strategies for Learning Questionnaire (MSLQ) were consistent with reported experience of higher competence and social relatedness.

2.1.2   College Student Motivation

The college experience, in particular, is fraught with motivating and demotivating events. The first year can be especially demotivating (Pascarella & Terenzini, 1991). However, after the first year, it should be no surprise that students' academic self-concepts appear to increase, so much so, that by the end of their senior year, their academic self-concept is greater than it was at the beginning of their freshman year (Pascarella & Terenzini, 1991; Astin, 1977).

Wolters (1998) suggests that students who made use of self-imposed extrinsic regulators to maintain their involvement in academic tasks may receive higher course grades than other students who did not use these strategies. Instructors can promote internalized motivation in their students by providing meaningful rationales for the activities (value) and opportunities for students

to interact with each other (relatedness) (Lepper & Henderlong, 2000; Su & Reeve, 2011; Reeve, 2012; Vaino et al., 2012).

2.1.2.1   Chemistry Student Motivation

Student motivation is a major concern in chemistry education. Johnstone (2006) claims that "So much of the gloom, which exists at present about the future of chemistry in schools and universities, is due to negative attitudes to the subject and these must be related directly to bad experiences which pupils and students have had in chemistry lessons," (p. 61). This distaste may only be exacerbated by the fact that chemistry courses remain a *requirement* for many college students in varying degree programs (Xu, Villafane, & Lewis 2013; Ferrell & Barbera, 2015). Along the same lines, Cook, Kennedy, and McGuire (2013) assert that "college students often find general chemistry to be a very challenging rite of passage on their way to degrees in various science, technology, and mathematics disciplines" (p. 961). Ferrell and Barbera (2015) also underscored that student struggles may be a result of the combination of content difficulty and the fact that students are only fulfilling a credit requirement for their non-chemistry majors.

Various studies have been run to study the affective profiles of students taking chemistry (e.g. Austin et al, 2018; Chan & Bauer, 2015; Lynch & Tujillo, 2010; Zusho, Pintrich, & Coppola, 2003) and the motivational consequences of various interventions (Liu, Raker, & Lewis, 2018; Vaino, et al, 2012; Black & Deci, 2000). However, the literature is lacking in an understanding of the actual experiences of the students. This study provides a foundation to address this gap.

2.2   Flipped Learning

Blended instruction (e.g. flipped, hybrid, inverted) has become a popular pedagogical method amongst educators and has the potential to influence student motivation in chemistry (Bishop & Verleger, 2013; O'Flaherty & Phillips, 2015). While there have been different studies on the benefits of flipped learning, in particular (O'Flaherty & Phillips, 2015; U.S. Department of Education, 2010), there is still much to learn about how students experience it.

Baker (2000), often cited as the first to use the flipped classroom, illustrates what makes a flipped classroom different from a traditional classroom. The main difference is that lecture material is presented outside of the normal class time, which provides the time for students to

participate in learning activities based on this material during the normal class session. Baker (2000) explains that in flipped learning, instruction is presented online before students come to the classroom and then students have the opportunity to further engage with the material by participating in collaborative activities during the normally scheduled in-class session.

The benefits of flipped learning have even been suggested as a solution to the problems faced in teaching large enrollment courses specifically with regard to its potential to incorporate asynchronous instruction (Marsh, McFadden, & Price, 2003). In asynchronous instruction, students are able to plan their own learning outside of the classroom by viewing the lectures during a time that is most convenient for them. In this way, a flipped course uses "technology to invert the traditional teaching environment by delivering lectures online as homework and opening up the class period for interactive learning" (Tucker, 2012).

2.3   Perceptions in Flipped Learning

The majority of studies have shown positive responses from students experiencing the flipped format (Fautch, 2014; Enfield, 2013; Love, Hodge, Grandgenett, & Swift, 2013; McGivney-Burelle & Xu, 2013; Smith, 2013; Wilson, 2013). Others, such as Knight and Wood (2005), highlight an initial resistance to this format that decreased after an adjustment period where students became more comfortable. Christiansen (2015) even states that students found the flipped method more preferable after this adjustment period. However, there are some studies that have found that even though most student evaluations of these courses remain stable compared to traditional courses, it is not an instructor-proof method (Wieman, Perkins & Gilbert, 2010; Seidel & Tanner, 2013). These include cases where the instructor planned poorly, had technological issues, or exhibited negative behavior in the classroom (i.e. underprepared, apathetic, inaccessible, etc.) (Siedel & Tanner, 2013).

A review of the flipped classroom literature by Bishop and Verleger (2013) concluded that student perceptions were fairly consistent across the studies examined and were generally positive. Despite this trend, researchers found that some students highly disliked the format (Bishop & Verleger, 2013). Strayer (2012) demonstrated this in a statistics course where students expressed their openness to cooperative learning but reported less satisfaction with the preparation they were provided before completing assignments for the course. In a separate study, students in a web-

supported class were also eager about the collaborative aspects but frustrated with the web-based instruction (Frederickson, Reed, & Clifford, 2005).

In a more recent review of the literature on flipped learning in higher education, O'Flaherty and Phillips (2015) found that the flipped approach improved academic performance and student satisfaction. However, it is difficult to achieve positive results when instructors fail to understand the key features of implementing this approach. When these results are not achieved, professors may exhibit the negative behavior mentioned earlier, such as blaming the pedagogical method or the students' efforts.

Finally, Sturtevant (2016) explained that while students expressed in the surveys that they were highly frustrated with the flipped format they still performed just as well on a standardized exam as students in the traditional course. This is not to suggest that it is okay to continue using a pedagogical style that frustrates students as long as there is no change in their performance. It is simply highlighting that perceptions of the course did not appear to influence their performance. This suggests a need to understand the source of the students' frustrations with the course and determine what can be done to remediate them. Sturtevant (2016), in fact goes on to state that an instrument to measure motivation was not used and that this "[...] would be an excellent idea to incorporate for future work seeking to better […] understand what determines student success in this course" (p. 214). Seery (2015), also points out the importance of a qualitative study of this nature explaining that, "it's already clear that comparing average performances between control and experimental groups misses nuances that are already emerging from the studies shown, and examining what happens to students individually, through qualitative work or cluster analysis, will likely offer more valuable information" (p. 766).

As blended learning pedagogies (flipped learning in particular) become more prevalent in the chemistry classroom, it is important to investigate the effects that it can have on a student's interest in learning chemistry. This study expands Sturtevant's (2016) research in order to explore some of those nuances mentioned by Seery (2015), by investigating the student and TA perceptions of a second semester flipped general chemistry course.

2.4   References

Astin, A. (1977). *Four critical years: Effects of college on beliefs, attitudes, and knowledge.* San Francisco: Jossey-Bass.

Austin, A. C., Hammond, N. B., Barrows, N., Gould, D. L., and Gould, I. R. (2018). Relating motivation and student outcomes in general organic chemistry. *Chem. Educ. Res. Pract., 19,* 331-341.

Baker, J. W. (2000). *The "classroom flip": Using web course management tools to become the guide by the side.* Paper presented at the 11th International Conference on College Teaching and Learning, Jacksonville, FL.

Baumeister, R. F. and Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*(3), 497-529.

Ben-Eliyahu, A., Moore, D., Dorph, R., and Schunn, C. D. (2018). Investigating the multidimensionality of engagement: Affective, behavioral, and cognitive engagement across science activities and contexts. *Contemporary Educational Psychology, 53,* 87-105.

Bishop, J. L., & Verleger, M. A. (2013). The flipped classroom: A survey of the research. Proceedings of the ASEE Annual Conference, 23–26 June 2013, Atlanta, GA.

Black, A. E. and Deci, E. L., (2000), The effects of instructors' autonomy support and students' autonomous motivation on learning organic chemistry: A self-determination theory perspective, *Sci. Educ., 84*(6), 740–756.

Chan, J. Y. K. and Bauer, C. F. (2015). Effect of peer-led team learning (PLTL) on student achievement, attitude, and self- concept in college general chemistry in randomized and quasi experimental designs, *J. Res. Sci. Teach., 52*(3), 319–346.

Christiansen M. A., (2014), Inverted teaching: applying a new pedagogy to a university organic chemistry class, *Journal of Chemical Education*, *91*(11), 1845–1850

Cook E., Kennedy E. and McGuire, S. Y. (2013). Effect of teaching metacognitive learning strategies on performance in general chemistry courses, *J. Chem. Educ., 90*, 961–967.

deCharms, R. (1968). *Personal causation*. New York.

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality, 19*(2), 109-134. Doi: http://dx.doi.org/10.1016/0092-6566(85)90023-6.

Enfield, J. (2013). Looking at the Impact of the Flipped Classroom Model of Instruction on Undergraduate Multimedia Students at CSUN. *TechTrends: Linking Research and Practice to Improve Learning*, *57*(6), 14–27.

Fautch J. M., (2015). The flipped classroom for teaching organic chemistry in small classes: is it effective? *Chemistry Education Research and Practice*, *16*(1), 179– 186.

Ferrell, B. & Barbera, J. (2015). Analysis of students' self-efficacy, interest, and effort beliefs in general chemistry. *Chemistry education research and practice, 16*, 318-337.

Frederickson, N., Reed, P., & Clifford, V. (2005). Evaluating web-supported learning versus lecture-based teaching: Quantitative and qualitative perspectives. *Higher Education: The International Journal of Higher Education and Educational Planning, 50*(4), 645-664.

Friedman-Nimz, R. and Skyba, O. (2009). Personality qualities that help or hinder gifted and talented individuals. In L. V. Shavinina (Ed.), *International handbook on giftedness* (pp. 421-435). Quebec, Canada: Springer Science.

Johnstone, A. H. (2006). Chemical education research in Glasgow in perspective. *Chem. Educ. Res. Pract., 7*(2), 49-63.

Knight, J.K., & Wood, W.B. (2005). Teaching more by lecturing less. *Cell Biology Education, 4*(4), 298–310.

Koestner, R., and Losier, G. F. (2002). 5: Distinguishing three ways of being internally motivated: A closer look at introjection, identification and intrinsic motivation. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (101-121). Rochester, NY: The University of Rochester Press.

Lepper M. R. and Henderlong J., (2000), Turning ''play'' into ''work'' and ''work'' into ''play'': 25 years of research on intrinsic versus extrinsic motivation. In C. S. J. M. Harackiewicz (Ed.) *Intrinsic and extrinsic motivation: The search for optimal motivation and performance* (257-307). San Diego, CA: Academic Press.

Liu, Y., Raker, J. R., and Lewis, J. E. (2018). Evaluating student motivation in organic chemistry courses: Moving from a lecture-based to a flipped approach with peer-led team learning. *Chem. Educ. Res. Pract., 19*, 251-264.

Love, B., Hodge, A., Grandgenett, N., & Swift, A. W. (2013). Student learning and perceptions in a flipped linear algebra course. *International Journal of Mathematical Education in Science and Technology*, *45*(3), 317–324.

Lynch, D. J. and Trujillo, H. (2010). Motivational beliefs and learning strategies in organic chemistry. *International Journal of Science and Mathematics Education, 9,* 1251-1365.

Marsh, G. E. II, McFadden, A. C. and Price, B. J. (2003).*Blended instruction: Adapting conventional instruction for large classes. Online Journal of Distance Learning Administration, 6(4). Retrieved from* http://www.westga.edu/~distance/ojdla/

McGivney-Burelle, J., & Xue, F. (2013). Flipping Calculus. *PRIMUS*, *23*(5), 477–486.

Moos, D. C. and Honkomp, B. (2011). Adventure learning: Motivating students in a Minnesota middle school. *Journal of Research on Technology in Education, 43*(3), 231-252.

Myer, D. G. (2011). *Exploring Psychology* (8th ed.). New York: Worth Publishers.

O'Flaherty J. and Phillips C., (2015), The use of flipped classrooms in higher education: a scoping review, Internet Higher Education, *25*(1), 85–95.

Pascarella, E. T. and Terenzini, P. T. (1991). *How college affects students: Findings and insights from twenty years of research.* San Francisco: Jossey-Bass.

Pintrich, P. (1999). The role of motivation in promoting sustained self-regulated learning. *International Journal of Educational Research, 31*(6), 459-470.

Reeve, J. (2002). 9: Self-determination theory applied to educational settings. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (183-203). Rochester, NY: The University of Rochester Press.

Reeve J., (2012), A self-determination theory perspective on student engagement. In S. Christenson, A. Reschly, and C. Wylie (Eds.) *Handbook of research on student engagement* (149-172). New York: Springer Science + Business Media.

Reeve, J., Bolt, E., and Cai, Y. (1999). Autonomy-supportive teachers: How they teach and motivate students. *Journal of Educational Psychology, 91*(3), 537-548.

Reeve, J., Jang, H., Carrell, D., Jeon, S., & Barch, J. (2004). Enhancing students' engagement by increasing teachers' autonomy support. *Motivation & Emotion, 28*(2), 147-169.

Reis, H. T. (1994). Domains of experience: Investigating relationship processes from three perspectives. *Theoretical frameworks for personal relationships*, 87-110.

Ryan, R. M. & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25,* 54-67.

Ryan, R. M., & Deci, E. L. (2002). 1: Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (3-33). Rochester, NY: The University of Rochester Press.

Seery, M. K. (2015). Flipped learning in higher education chemistry: emerging trends and potential directions. *Chemistry Education Research and Practice*, *16*(4), 758–768.

Seidel, S.B., & Tanner, K. D. (2013). "What if students revolt?"—Considering student resistance: Origins, options, and opportunities for investigation. *CBE—Life Sciences Education, 12*(4), 586–595.

Sierens, E., Vansteenkiste, M., Goossens, L., Soenens, B., and Dochy, F. (2009). The synergistic relationship of perceived autonomy support and structure in the predication of self-regulated learning. *British Journal of Educational Psychology, 79,* 57-68.

Smith J. D., (2013), Student attitudes toward flipping the general chemistry classroom, *Chemistry Education Research and Practice*, *14*(4), 607–614.

Strayer, J. F. (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research*, *15*(2), 171- 193.

Sturtevant, H. G. (2016). *Design, implementation, and evaluation of a hybrid scale-up model for general chemistry courses.* Purdue University, West Lafayette, IN.

Su Y.-L. and Reeve J. (2011) A meta-analysis of the effectiveness of intervention programs designed to support autonomy. *Educ. Psychol. Rev., 23*(1), 159–188.

Teodorescu, K. and Erev, I. (2014). Learned helplessness and learned prevalence: Exploring the causal relations among perceived controllability, reward prevalence, and exploration. *Psychological Science*, *25*(10), 1861–1869.

Tucker, B. (2012). The Flipped Classroom. *Education Next*, *12*(1). Retrieved from http://educationnext.org/the-flipped-classroom/

U.S. Department of Education, Office of Planning, Evaluation, and Policy Development. (2010). *Evaluation of evidence-based practices in online learning: A meta- analysis and review of online learning studies* (Contract No. ED-04-CO-0040)*.* Retrieved from www.ed.gov/about/offices/list/opepd/ppss/reports.html

Ulusoy, Y. and Duy, B. (2013). Effectiveness of a psycho-education program on learned helplessness and irrational beliefs. *Kuram ve Uygulamada Egitim Bilimleri*, *13*(3), 1440–1446.

Vaino, K., Holbrook, J., and Rannikmae, M. (2012). Stimulating students' intrinsic motivation for learning chemistry through the use of context-based learning modules. *Chem. Educ. Res. Pract., 13*(4), 410–419.

Vallerand, R. J. and Ratelle, C. F. (2002). 2: Intrinsic and extrinsic motivation: A hierarchical model. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (37-63). Rochester, NY: The University of Rochester Press.

Vansteenkiste, M., Lens, W., and Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation. *Educ. Psychol., 41*(1), 19–31.

Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K. M., and Deci, E. L. (2004). Motivating learning, performance, and persistence: The synergistic role of intrinsic goals and autonomy-support. *Journal of Personality and Social Psychology, 87*, 246–260.

White, R. W. (1963). Ego and reality in psychoanalytic theory. *Psychological Issues, 3*, 1-210.

Wieman, C., Perkins, K., & Gilbert, S. (2010). Transforming science education at large research universities: A case study in progress. *Change: The Magazine of Higher Learning, 42*(2), 6–14.

Wild, T. C. & Enzle, M. E. (2002). 7: Social contagion of motivational orientations. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (141-157). Rochester, NY: The University of Rochester Press.

Wilson, S. G. (2013). The Flipped Class A Method to Address the Challenges of an Undergraduate Statistics Course. *Teaching of Psychology*, *40*(3), 193–199.

Wolters, C. A. (1998). Self-regulated learning and college students' regulation of motivation. *Journal of Educational Psychology, 90*, 224–235.

Xu, X., Villafane, S. M., and Lewis, J. E. (2013) College students' attitudes toward chemistry, conceptual knowledge and achievement: Structural equation model analysis. *Chem. Educ. Res. Pract., 14*(2), 188–200.

Zusho, A., Pintrich, P. R., and Coppola, B. (2003) Skill and will: The role of motivation and cognition in the learning of college chemistry. *Int. J. Sci. Educ., 25*(9), 1081–1094.

CHAPTER 3.   METHODOLOGY

In order to evaluate student perceptions of a flipped, second-semester, general chemistry course, a qualitative phenomenographic study was conducted. The framework, context, data collection methods, data analysis methods, and trustworthiness of the study are discussed in this chapter.

3.1   Theoretical Framework

As a novice qualitative researcher at the beginning of this project, the researcher embraced his role as a *bricoleur* engaging in generic qualitative inquiry (Caelli, Ray, & Mill, 2003; Denzin & Lincoln, 2004). The term *bricoleur* comes from Levi-Strauss (1966) who introduced it from the French tradition of one who "traveled the countryside using odds and ends, whatever material was at hand, to perform fix it work" (Patton, 2015, p. 153). In the case of qualitative research, the *bricoleur* crafts and conducts his study with the resources available (Denzin & Lincoln, 2011). As a study built upon the available resources with the intent of understanding and improving a flipped learning program in chemistry, generic qualitative inquiry was used by "asking open-ended questions … and observing matters of interest" (Patton, 2015, p. 154). For this researcher, however, a clear paradigm emerged in the midst of his study, and he moved on to frame his work, or *bricolage,* using the theoretical framework of phenomenography.

Phenomenography is a theoretical framework that positions researchers so that they can study the ways in which individuals experience a given phenomenon (Orgill, 2007). The goal of this type of framework is to provide a "description, analysis, and understanding of experiences," (Marton, 1981) and to characterize the variations in individual accounts of those experiences (Trigwell, 2000).

To achieve this characterization, a researcher investigates the underlying meanings of and connections between the perceptions of participants who have experienced a common phenomenon. In doing this, the researcher brings awareness to a previously implicit experience by providing language and opportunities for participants to express it (Gardner & Bodner, 2007).

There should be no surprise that this framework has natural applications to educational research, especially when considering experiences in the classroom and their variations between

members. This framework has been used in educational research including chemical education studies (e.g. Bhattacharyya & Bodner, 2005; Gardner & Bodner, 2007; Dekorver & Towns, 2015). However, this is not limited to experiences of students alone, but can be expanded to account for teachers' experiences with the learning and teaching process as well (Svensson, 1997). Using phenomenography to collect and analyze data on how instructors, teaching assistants, and students experience a common course, could lead to an improvement in how that course is conducted in the future.

3.1.1 Self-Determination Theory

Self-determination theory, discussed more in the literature review, allows the researcher to apply a lens to see the influence that various social contexts have on the ways individuals perceive a course. Rather than applying self-determination theory directly as a framework, the model guided the development of methods, such as informing the types of questions asked during the interviews.

During the analysis, results were drawn directly from the data, rather than applied to this model. Here results are not intended to be explained entirely by self-determination theory, rather this theory will be used to guide interpretation of the study. The following study used this lens to characterize and compare how different social contexts influence students' perceptions of the course.

3.2 Context

This study took place during the Fall 2017 semester of a four-credit hour, second-semester general chemistry course for science and engineering majors at a large, midwestern, R1 university. The course was 17 weeks long, including a one week break for Thanksgiving and a week dedicated to the course's final examination.

The course content included a general overview of the following topics:

- chemical kinetics
- chemical equilibrium
- acid-base chemistry (including buffers and titrations)
- thermochemistry (including enthalpy, entropy, and reaction spontaneity)

- electrochemistry (including electrochemical cells, redox chemistry, electrode potentials, and electrolysis)

According to instructors, this course had been taught previously using a flipped format of learning during the 2015 and 2016 semesters. In flipped courses, online learning is combined with in-class work. Specifically, for this iteration, students experienced flipped learning by watching online lectures outside of class and attended a weekly, one-hour and 50-minute problem-solving session (recitation) where they applied the concepts from the online lectures. Students were enrolled in one out of four recitation sections that occurred each week. This was in addition to the homework assignments and laboratory sessions.

For each recitation the instructor and Head TA were present to move between different sections and help students. During the first ten minutes of each recitation, students were given a pre-class quiz on the material that was covered during the online lectures. After the quiz, students would work in small groups of no more than six to solve these problems. These groups were assigned by the Head TA and were reassigned after each exam. After being given a period of time to complete each problem, a student would be chosen at random from each subsection of 24 students. This student would go up to a small whiteboard on the side of the classroom and provide an explanation of the problem for the rest of their peers in their subsection. The student and their group of no more than six, would receive a score based on how well the individual student presented the solution according to a standard rubric provided by the course instructors. There could be up to five subsections present during one recitation, though usually there were only four.

Students were simultaneously enrolled in a laboratory course with the same students in their subsection. During the laboratory course students would follow the instructions in a laboratory manual to complete an experiment. They would begin the laboratory session with a short lab quiz based on the background information provided in the manual. After the quiz, students would complete the experiment, taking notes as they went. After the experiment students would complete a worksheet on their results and turn them in to their TA.

There were two instructors who split their responsibilities during the semester. Dr. Bradley was responsible for the first half of the semester and Dr. Steve was responsible for the second half of the semester. Both instructors had taught previous iterations of this course in the traditional and flipped formats. They were responsible for preparing the course content, creating online lecture

videos, planning the in-class recitations and writing the in-class problems, developing grading rubrics, writing quizzes and exams, assigning homework from the online homework platform, and managing the administration of the course.

The course also made use of graduate teaching assistants (TAs) from the Department of Chemistry. All of the TAs were graduate students in the department's doctoral program. There were ten TAs with two additional "Head TAs." One Head TA managed administrative details related to the laboratory course work, while the other managed administrative details related to the in-class sessions. The other ten TAs were responsible for at least one subsection of approximately 24 students, though most TAs were responsible for two subsections. The TAs' responsibilities included supervising and assisting student laboratory sessions, grading student laboratory reports, grading pre-class quizzes, evaluating student in-class presentations, holding at least one hour of office hours to assist students, and facilitating collaborative work during the recitations.

The course also made use of Supplemental Instruction, or SI. This program consisted of student facilitated study sessions supported by the department. An undergraduate student who had previously taken the course was hired as the SI Leader. The SI Leader provided additional support to the current students by planning peer led study sessions for students to attend.

The different assessments that students had to complete were:

- 14 homework assignments (seven points each)
- in-class performance (i.e., presentations) (140 points in total)
- 12 pre-class quizzes (five points each)
- ten lab quizzes (ten points each)
- 11 laboratory reports (15 points each)
- three exams (125 points each)
- final exam (250 points)

The lowest grade for each assessment is dropped at the end of the semester resulting in the following point distributions:

- homework assignments (91 points) (~9% of total)
- in-class performance (i.e., presentations) (140 points) (~13% of total)

- pre-class quizzes (55 points) (~5% of total)

- lab quizzes (90 points) (~9% of total)

- laboratory reports (150 points each) (~15% of total)

- exams (500 points) (~49% of total)

The homework assignments were accessed through an online homework management system. Students were given two attempts to complete the assignment and three attempts for each question in each assignment attempt. Essentially, this gave students a total of six attempts per question in each homework assignment. The number of questions varied for each assignment, but the amount of points remained the same.

The points for the in-class performance assignments could only be earned if the student was in attendance. The points were awarded based on individual presentations from their group. Each presenter was evaluated by their TA for "clarity of explanation," "accuracy," and "completeness." Each of these criteria were on a scale of one to five for a total of 15 points. The score was awarded to every member of the group that the presenter was a part of. Since the presenters were selected at random, not all groups would present during each session and some groups may present multiple times. At the end of the semester the scores of individual students were scaled so that each students' in-class performance grade was out of 140 points.

The pre-class quizzes were administered during the first ten minutes of each recitation and covered the readings and videos that were assigned prior to class. The quizzes consisted of five multiple choice questions, and a score less than a three out of five was considered a failing grade for the quiz. If a student failed a quiz, they would also lose 25% of their in-class performance points for that day, and would lose 50% of their in-class performance points for each additional failed quiz until they earned a passing quiz grade. At this point it would be reset, so that their next failed quiz would only result in a 25% deduction of their in-class grade.

Laboratory quizzes were administered online and were due prior to students attending the corresponding laboratory session. Each quiz covered material from the pre-lab exercises and laboratory manual procedure. Students who took the quiz, but failed to attend lab would receive a zero for that quiz. Each quiz had five multiple choice questions and students were given ten minutes to complete them.

Laboratory reports were composed of pre-lab exercises, relevant graphs and tables, data calculations, and discussion questions addressing the results. Students would submit these in pairs or groups of four. Students also completed Peer and Self Evaluation forms for each laboratory session. These forms would be used to assign points to individuals in the group based on their peers' perceptions of their preparedness and effort.

The examinations were used as an opportunity for students to demonstrate their comprehension of the course material and were administered at three separate intervals during the semester with a fourth final examination at the end of the semester. The first three exams covered specific content that was covered during the intervals between each examination. For example, exam two did not cover content from exam one. Each of these exams were a combination of multiple choice questions worth a total of 80 points, and three free-response questions each worth 15 points. The final examination was cumulative, with the first part covering content between exam three and the final. The second part was a standardized national exam that covered the material from the entire course.

The study subjects involved the students enrolled in the course and the TAs assigned to the course. An outline of the context, participants, and data sources can be found in Table 3.1. The data collected allow the researcher to characterize the experiences of students in the course.

Table 3.1. Overview of participant and data source alignment. This table illustrates how the data sources are aligned with the different participants in the study

Context	Subjects	Data Sources
Fall 2017 Flipped Second Semester General Chemistry Course for Engineering and Science Majors	Students	Focus Group
		Interviews
		Course Evaluations
	TAs	Interviews

3.3   Data Collection

Data were collected through the means of a focus group discussion and individual interviews with students and TAs, as well as a course evaluation provided by the instructor (Table 3.2). The focus group discussion and all interviews were audio and video recorded, and transcribed.

Data were collected after the completion of the flipped course, throughout the Spring 2018 and the beginning of the Summer 2018 semesters. The student focus group discussion was held at the beginning of the Spring semester. The focus group discussion was guided by an overarching question and responses were further explored for elaboration and clarity. Preliminary data from the focus group discussion were used to inform additional questions in the interview protocol that had been originally developed using perspectives from self-determination theory. Preliminary student interview data were then used to further inform TA interview protocols. The data were coded using emergent coding techniques and the results analyzed.

Table 3.2. Data Collection. This table shows the number of respondents for each data source

Data Source	Student Data			TA Data
Collection Method	Focus Group	Interviews	Course Evaluations	Interviews
Number of respondents	6	8*	181	4

*One interview was intended to be a focus group, but only one participant was involved

3.3.1 Students

The participants in this study were students who were enrolled in and completed the flipped second-semester general chemistry course for science and engineering majors, during the Fall 2017 semester. Student data were collected via a focus group discussion and individual interviews. The interview protocol was expanded upon based on topics that emerged from the focus group discussion.

Eight participants were recruited via email requests sent through the office of general chemistry during the Spring 2018 semester. Six participants were recruited for both the focus group discussion and individual interviews, and two additional participants were recruited just for individual interviews. These were the only students who volunteered to participate. All participants were compensated for their time in the individual interviews with a $20 voucher for the student union. Focus group participants were compensated for their time with refreshments during the focus group session. To protect their identities, all participants were given pseudonyms.

Participants included sophomores, juniors, and one senior and a variety of different majors. Participant pseudonyms, years in school, and majors are reported in Table 3.3. One participant,

Pete, had taken the course during the preceding semester (Spring 2017) when it was taught in a traditional lecture format and was retaking it during the Fall.

3.3.1.1   Student Focus Group

During the Spring 2018 semester, emails were sent out to recruit participants from the Fall 2017 flipped course for the study. Initial data were collected during a focus group session with six students who indicated an interest in participating in the study and were taking the course for the first time. The focus group discussion was conducted in two phases. During the first phase, participants were given a brief overview of the project, then asked about their demographics (specifically year in school, major, and whether they were taking the course for the first time or were repeating it), and given the opportunity to ask questions of the researcher.

Table 3.3. Student Demographics. This table provides an overview of student demographics including their year in school, major, whether they were repeating the course, whether they participated in the focus group discussion, and whether they participated in an interview

Participant	Year*	Major	Repeat	Focus Group**	Interview**
Harold	Senior	Electrical Engineering	First	Y	Y
Ashley	Sophomore	Corporate Communication	First	Y	Y
Megan	Sophomore	Vet	First	Y	Y
Chelsii	Sophomore	Nutrition	First	Y	Y
Isabella	Sophomore	Chemical Engineering	First	Y	Y
Max	Junior	Material Sciences	First	Y	Y
Pete	Sophomore	Communications	Repeat	N	Y
JoJo	Junior	Psychology	First	N	Y

*Self-reported years
**Y indicates participation; N indicates nonparticipation

The remainder of the focus group discussion consisted of an open discussion directed by the following prompt:

> *Please articulate your experiences from the flipped version of* [general chemistry] *this past Fall, compare it with your prior experiences in more traditional courses, and discuss how this influenced your interest in the topic of chemistry.*

Probes such as: "Could you explain this further?", "How did that make you feel?", and "Does someone else have a different perspective?", were used to clarify responses to the initial prompt and elicit responses from other participants.

3.3.1.2   Student Interviews

After the focus group discussion was conducted, the audio and video recordings were reviewed for topics and comments to investigate further in individual interviews. The six original members of the focus group discussion, plus two additional participants for a total of eight participants, were recruited for individual interviews. A semi-structured, conversational style (Creswell, 2009) was utilized throughout four phases of the interview. During the first phase, participants were given a brief overview of the project, were asked about their demographics (specifically year in school, major, and whether they were taking the course for the first time or were repeating it), and given the opportunity to ask questions of the researcher.

During the second phase, participants were given the opportunity to provide a general reflection on the prompt given during the focus group discussion:

> *Please articulate your experiences from the flipped version of* [general chemistry] *this past Fall, compare it with your prior experiences in more traditional courses, and discuss how this influenced your interest in the topic of chemistry.*

During the third phase, participants were given a series of prompts by the researcher and were instructed to reflect on them aloud. The prompts were informed by the basic psychological needs and continuum of motivational regulators found in self-determination theory (Ryan & Deci, 2002; Vansteenkiste, Lens, & Deci, 2006). These questions are listed below:

- What influence did the instructor have on your interest/perception of chemistry?
- Tell me about your thoughts of the instructor.

- Why did you choose to take this course?
- Do you believe that the course content is relevant for you and your career goals?
- Do you believe that you have benefited from taking this course?
- Do you believe that you were given adequate opportunities to show how capable you were with the content?

The fourth and final phase of the interview consisted of questions developed from preliminary data found in the focus group discussion and one interview with a student who was repeating the course. A series of statements and themes were identified to add as topics that participants were asked to comment on during the remaining individual interviews. The comments fell under the themes found in Table 3.4. Students who participated in interviews were asked to reflect and comment on these statements. Students who chose to participate in both the focus group discussion and an interview, were also asked to further elaborate on some of the comments that they made during their focus group.

3.3.1.3 Course Evaluations

One of the instructors from the course provided a copy of the students' evaluations of the course. These evaluations are developed, distributed, compiled, and analyzed by the University's Center for Instructional Excellence in order to aid in the improvement of courses. At the end of the semester, students were asked to evaluate the course and the instructor by completing an online survey. The students also had the opportunity to evaluate their TAs as well in a separate online survey for their assigned section, which was not collected or analyzed here.

The evaluation collected data on the course and instructor using a five-point Likert scale, as well as two free response questions. The researcher paid particular attention to the free response questions.

3.3.2 Graduate Teaching Assistants (TAs)

TAs who were assigned to the same iteration of the course as the student participants were also participants in this study. During the Spring 2018 semester, emails were sent out to recruit TA participants from the Fall 2017 flipped course for the study. TA data were collected via individual

interviews. The interview consisted of four phases. During the first phase, participants were given a brief overview of the project, were asked about their demographics (specifically year in school, whether they have previously taught and/or taken a flipped course, and whether they have previously taught the traditional version of this course), and given the opportunity to ask questions of the researcher (Table 3.5).

Table 3.4. Themes from Focus Group. This table provides the themes and sample comments that emerged from the preliminary review of the focus group discussion.

Theme	Sample Positive Comment	Sample Negative Comment
Content relatedness	*having that hands-on approach to it[…], that definitely helped me learn the material better.*	*It felt like the course was a second thought.*
Feelings	*I feel like if a lot of classes were set up this way, I would've learned better.*	*I liked the online lectures. It was the in-class recitation that I didn't like.*
Support	*They were moving around the room, but they were always available and very able to explain what I needed to do*	*I'm not saying that we were set up for failure, but we weren't set up for success.*
Presentations	*They added the motivation that we needed to understand the material, because with a presentation, there was always the risk that you would get called up*	*…someone could be great at chemistry, but have horrible presentation skills.*
Individual effort	*I've never worked so hard in a course as I did in CHM 116.*	*I stopped watching those videos,*

During the second phase, participants were given the opportunity to provide a general reflection on a modified version of the focus group discussion prompt given to the student participants:

Please articulate your experiences from the flipped version of [general chemistry] *this past Fall and compare it with your prior experiences in more traditional courses that you have TA-ed.*

Table 3.5. Graduate Teaching Assistant Participant Demographics. This table provides an overview of TA experiences related to flipped learning. It provides their year in grad school and whether they have previous experience teaching a flipped course, taking a flipped course, or teaching the traditional version of the course being studied.

Participant	Year	Taught Flipped Previously*	Taught Traditional Version Previously*	Taken a Flipped Course Previously*
Chloe	Second	Y	Y	Y
John	Third	Y	Y	Y
Leah	Second	N	N	Y
Susie	Second	N	Y	Y

*Y indicates participation; N indicates nonparticipation

During the third phase a base set of interview questions from the student interviews were modified for the TAs as follows:

- As a TA, you may have had an opportunity to take a flipped course of your own. If you have, can you comment on any comparisons to this version?
- Tell me about your thoughts of the instructor. (did you feel supported, informed, were you aware of their intention for the course, etc.?)
- Do you believe that the course content is relevant for your students and their career goals?
- Do you believe that your students benefited from taking this course?
- Do you believe that you benefited from teaching this course?
  - Were you able to develop your pedagogical skills?
- Do you feel that you were given adequate opportunities to demonstrate your competence of chemistry?
- Do you believe that you were given adequate opportunities to demonstrate competence as a TA?
- Do you believe that you were able to adequately support your students?

   o How did you support your students?
- Did you feel prepared for the recitations?
   o How did you prepare for the recitations?

Throughout these questions, the TA participants were asked to reflect on their own experiences as well as their perceptions of their students' experiences.

The fourth and final phase of the interview consisted of questions developed from the preliminary data found in the focus group discussion and one interview with a student who was repeating the course. A series of statements and themes were identified to add as probes during the TA interviews. The comments fell under the themes found in Table 3.4. TAs were asked to reflect and comment on these statements.

3.4 Data Analysis

3.4.1 Focus Group & Interview Transcription

Once the focus group discussion and interview data were collected, they were transcribed and filler words such as "um," "uh," and "like" were removed. The transcripts were reviewed once along with the audio after being transcribed to assure fidelity, and identifying statements, such as names, were deidentified with pseudonyms or removed.

Once finalized, all transcripts were imported into NVivo 12 for data management and analysis. This software allowed the researcher to code portions of each transcript and organize coded sections across transcripts into themes.

3.4.2 Coding Process

All interview and focus group discussion transcripts, as well as the evaluation documents, were analyzed using inductive and deductive open coding (Saldaña, 2016). For inductive coding, new explanations were generated from the qualitative data, while deductive coding used existing explanations to describe the qualitative data (Patton, 2015). Since the coding process is open to the themes that emerge from the data, it is called *open coding* (Merriam & Tisdell, 2016).

To inductively develop these codes, Bryman's (2008) four stages of code development was used. This method involves the following steps (Bryman, 2008):

1. Reviewing a random transcript from the sample data;
2. Re-reading the transcript and marking it for emergent themes (done twice for this project);
3. Reviewing these themes and collapsing similar themes to avoid redundancy;
4. Organizing the themes into a final list of codes for subsequent deductive coding in the remaining documents.

This was done on a random student interview in conjunction with another member of the research group. During steps 3 and 4, the researcher and research group member discussed the emergent themes and organized them into categories. Once consensus was achieved between the two, the researcher independently coded the remaining student transcripts using NVivo 12. These codes were constantly compared to detect additional themes that emerged throughout the coding process (Saldaña, 2016).

The same codes were applied to the focus group discussion and the course evaluation. A modified version of the codes was used in the TA interviews in order to triangulate the data for final analysis (Merriam & Tisdell, 2016).

3.5 Trustworthiness

In order to establish the trustworthiness of the data, it is important to acknowledge the credibility of the data sources and the reliability of the instrument (Merriam & Tisdell, 2016). By collecting data from sources with different roles in the class (TAs and students) and in different formats (focus group, interviews, and a course evaluation), the researcher made use of data triangulation to demonstrate the credibility and internal validity of the data sources (Denzin & Lincoln, 2011).

Demonstrating the reliability of the instrument, however, requires a little more discussion. As a *bricoleur,* the researcher gathers materials, and constructs a "set of representations that are fitted to the specifics of a complex situation," (Denzin & Lincoln, 2011, p. 4). "The result of the *bricoleur's* method is a bricolage, a construction that arises from interrogating 'all the heterogeneous objects'" that he has collected (Weinstein & Weinstein, 1991, p. 161). The researcher as a *bricoleur* is the instrument in qualitative research. He has collected "heterogeneous

objects" in the form of a focus group, interviews, and a course evaluation in order to craft his *bricolage* of this study. In order to establish the reliability, and ultimately the trustworthiness of his work, it is important to outline his role as the researcher and potential biases, the inter-rater reliability of his codes, and the limitations of his work. These will all be discussed in this section.

3.5.1   The Role of the Researcher & Potential Biases

As the researcher, I was involved in all aspects of facilitating this study. I designed the study, collected and analyzed the data, and compiled the results. The details of the methodology were finalized with the assistance of my advisors and members of my research group. During data collection, I set up recording equipment, conducted all interviews and focus group discussions, and compiled transcripts. During data analysis, I inductively coded the transcripts using Bryman's four stages for code development (Bryman, 2008).

My background in chemistry and previous coursework qualify me for this work. As part of my graduate coursework, I took several classes in qualitative research design and educational psychology. These courses provided the foundation for me to design, conduct, and analyze a study focused on student perceptions of a general chemistry course.

Prior to graduate school, I completed a Bachelor of Science degree in chemistry at Fresno Pacific University. While at Fresno Pacific University, I gained experience as a Supplemental Instruction Leader for general chemistry, a laboratory teaching assistant for general chemistry and general physics, and as an adjunct instructor for general chemistry. These experiences provided opportunities for students to express their frustrations and desires for the course, which gave me insight into how other students perceived chemistry and the environment in which they learned it.

These experiences also introduced potential biases that may influence my expectations of what students perceived. In my instructional roles during my time at Fresno Pacific University, I frequently encountered students who expressed a variety of perceptions and opinions about the course and chemistry in general. These perceptions ranged from boring to interesting and irrelevant to universally applicable. Throughout my interviews, I made a conscious effort to remain neutral and not express my own opinions to the participants. At the beginning of each interview with the participants, I let them know that I was interested in hearing about their perceptions of the course (both good and bad), and wanted it to be conversational. I did not comment on whether I agreed or disagreed with their perceptions. During the interviews, I spoke in a friendly conversational

style so that they would feel comfortable describing their experiences honestly. I also explained that the interviews were confidential and the instructors, TAs, and students would not have access to the transcript as a whole or any parts that could identify them.

3.5.2 Inter-Rater Reliability

Efforts to further remediate the inherent biases of the researcher were sought by assessing the inter-rater reliability of the codebook. Additional raters were solicited to use the codebook definitions to independently analyze randomly selected transcripts. The first rater was asked to code a random transcript from the student interviews using the entire codebook. This rater was provided with the codebook via email and given a sample of coded work from another student transcript for reference. This sample was discussed and then the rater was given a random transcript to analyze independently. The analysis was done in NVivo 12 and a kappa of 0.70 was calculated between the researcher and the first rater. A kappa of 0.70 suggests a substantial agreement between raters when chance agreements are taken into account (Landis & Koch, 1977; Viera & Garrett, 2005).

The second rater was asked to code a random transcript from the TA interviews using the modified codebook. This rater was provided with the codebook via email and given a sample of coded work from another TA transcript for reference. This sample was discussed and then the rater was given a random transcript to analyze independently. The analysis was done in NVivo 12 and a kappa of 0.70 was calculated between the researcher and the second rater. A kappa of 0.70 suggests a substantial agreement between raters when chance agreements are taken into account (Landis & Koch, 1977; Viera & Garrett, 2005). These scores indicate that the codebooks developed by the researcher can be applied across the qualitative data by different raters with reliable results.

3.5.3 Limitations

While this study attempts to minimize limitations whenever possible, every research study has limitations that need to be considered when interpreting results. First, the generalizability of the findings would have been more convincing if samples of students were taken from multiple iterations of the course. While the data were collected in a limited time frame, thereby restricting the researcher's sampling options, multiple data sources (e.g., multiple interviews, focus group

discussion, course evaluations) were collected from different groups (e.g., TAs, students) within the study in order to increase the internal validity of the data.

Second, during the focus group discussion, individual participants took the opportunity to express their frustrations regarding the course being studied. In subsequent individual interviews, several subjects expressed the belief that they were influenced by their peers' frustrations and may have expressed a more negative perception of the course than they actually had. While this poses a threat to the validity of the data, transcripts of participants who were not part of the focus group discussion revealed similar themes. In addition, the recanting of impassioned perceptions of the course during the interviews, was taken into account when the researcher analyzed the focus group discussion transcript.

Finally, students may only have participated in the study to receive the compensation offered. Therefore, it is possible that the data collected in the interviews was at a superficial level, without deep thought.

3.6   References

Bhattacharyya, G., & Bodner, G. M. (2005). " It gets me to the product ": How students propose organic mechanisms. *Journal of Chemical Education*, *82*(9), 1402-1407.

Bryman, A. (2008). *Social Research Methods*. (3rd ed.). Oxford: Oxford University Press.

Caelli, K., Ray, L., & Mill, J. (2003). 'Clear as Mud': Toward greater clarity in generic qualitative research. *International Journal of Qualitative Methods, 2*(2), 1–13. https://doi.org/10.1177/160940690300200201

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Sage Publications, Inc.

Dekorver, B. K., & Towns, M. (2015). General chemistry students' goals for chemistry laboratory coursework. *Journal of Chemical Education, 92*, 2031-2037. https://doi.org/10.1021/acs.jchemed.5b00463

Denzin, N. K. & Lincoln, Y. S. (2011). The discipline and practice of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research*, (4th ed.) (pp. 1-19). Los Angeles: SAGE.

Gardner, D. E., & Bodner, G. M. (2007). Existence of a problem-solving mindset among students taking quantum mechanics and its implications. In M. D. Ellison & T. A. Schoolcraft (Eds.), *ACS symposium series: Advances in physical chemistry* (pp. 155-173). American Chemical Society: Washington, DC.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *International Biometrics Society*, *33*(1), 159–174. https://doi.org/10.2307/2529310

Levi-Strauss, C. (1966). *The savage mind* (2nd ed.). Chicago, IL: University of Chicago Press.

Marton, F. (1981). Phenomenography – Describing conceptions of the world around us. *Instructional Science*, *10*(2), 177-200.

Merriam, S. B. & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation.* (4th ed.). San Francisco, CA: Jossey-Bass.

Orgill, M. (2007). Phenomenography. In G. M. Bodner & M. Orgill (Eds.), *Theoretical frameworks for research in chemistry/science education* (pp. 127-145). Upper Saddle River, NJ: Pearson.

Patton, M. Q. (2015). *Qualitative research & evaluation methods.* (4th ed.). Saint Paul, MN: SAGE.

Ryan, R. M., & Deci, E. L. (2002). 1: Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (3-33). Rochester, NY: The University of Rochester Press.

Saldaña, J. (2016). *The coding manual for qualitative researchers*. (3rd ed.). J. Seaman (Ed.). SAGE.

Svensson, L. (1997). Theoretical foundations of phenomenography. *Higher Education Research & Development*, *16*(2), 159–171. https://doi.org/10.1080/0729436970160204

Trigwell, K. (2000). Phenomenography: Variation and discernment. *International Symposium Oxford Centre for Staff and Learning Development* (pp. 75–85). Oxford, UK.

Vansteenkiste, M., Lens, W., and Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation. *Educ. Psychol., 41*(1), 19–31.

Viera, A. J., & Garrett, J. M. (2005). Understanding interobserver agreement: The kappa statistic. *Family Medicine*, 360–363.

Weinstein, D., & Weinstein, M. A. (1991). Georg Simmel: Sociological ~~flaneur~~ bricoleur. *Theory, Culture & Society*, *8,* 151-168.

CHAPTER 4.   RESULTS: THE INFLUENCE OF STUDENTS' EMOTIONS AND REFLECTIONS IN THE COURSE

4.1   Overview of the Results Chapters

The results of this study are organized by the overarching themes that emerged from the data. Each theme encapsulates more specific categories that emerged during the analysis and relate to student perceptions and/or the affordances that influenced those perceptions.

The data from the student interviews revealed four overarching themes, 22 categories, and 33 codes used to assign qualitative data to categories in different ways. These codes were applied to student interviews, the focus group discussion, and the course evaluation. The codes were modified and condensed down to the 22 categories to be applied to the TA interview transcripts. The overarching themes that emerged from all sets of data are affective/self-reflective, relations, course design, and course actions. These are further defined below.

It is important to address that these are the students' and TAs' perceptions of the course and should not be assumed as facts of how the sessions were truly conducted. However, this does not mean that these perceptions are invalid. These experiences were expressed for a reason and considerations should be made for why the participants shared them. This is especially true for student experiences that are corroborated with TA observations.

Before examining the results it is worth saying that the final grades do not appear to have a clear effect on the students' perceptions of the course. The students who expressed an overall positive perception of the course, Max and Pete, received an A and a C, respectively. The students who expressed an overall negative perception of the course, Harold, Megan, and Chelsii, received a C, a D, and a C, respectively. The students who expressed a generally negative perspective, while maintaining an understanding of the course's intent, Ashley, Isabella, and JoJo, received a C, a B, and a C, respectively. Based on this data, it is not possible to infer whether or not grades influenced the participants' perceptions of the course. Their expectations, however, may have had an influence on their perceptions of the course as a C for one person may indicate success, while for another it may indicate failure.

The following three results chapters should be read as a catalog of the results under the themes of student emotions and reflections, the influence of different relationships, and the

perceptions of the design and execution of the course. Figure 4.1 provides an overview of these chapters along with the underlying categories that emerged from the data.
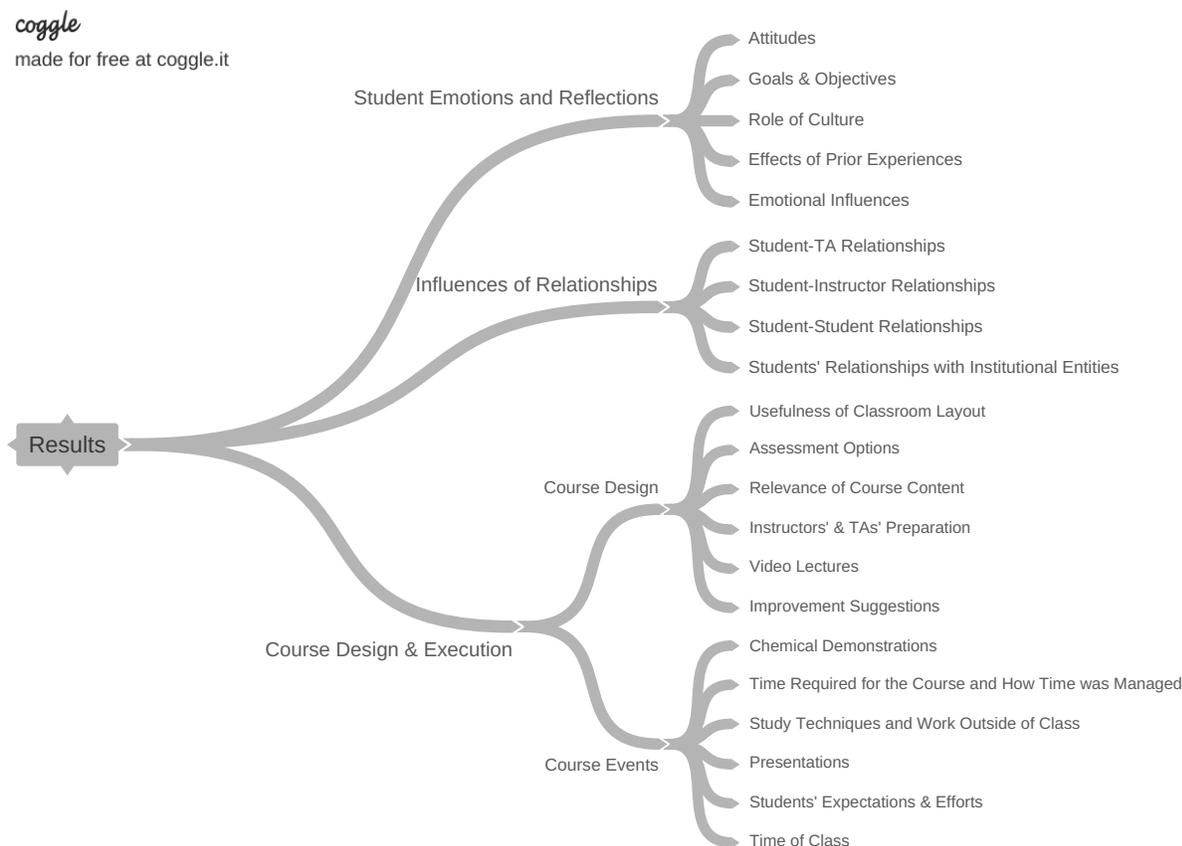
Figure 4.1. Overview of the Results Chapters. This mind map provides an overview of the different themes and corresponding categories in the different results chapters.

4.2 The Influence of Students' Emotions & Reflections in the Course

The codes that highlight students' emotions in relation to the course and their perspectives that direct their approach to the course are outlined in Table 4.1. The overarching *Affective/Self-Reflective* theme refers to any statements that highlight emotional components of taking the course, and experiences and perspectives that influence student and/or participant approaches to the course. This theme is further delineated between different constructs and perceptions that can direct a students' engagement with the course as well as the emotions and attitudes associated with the

course tasks and the general subject. The constructs, perceptions, and experiences emerged as influences to student participation in and attitudes towards the course.

4.2.1 Student Opinions Regarding the Topic of Chemistry and Chemistry Courses

The code *attitude/perception* is defined as statements that identify opinions directed towards chemistry, chemistry courses, and the agents associated with them (see Table 4.1 for definitions). This code focused more on perceptions and attitudes as they relate to chemistry, specifically.

Leah, one of the TA participants, recognized that many people in general are not excited about chemistry. She described her experiences with people when they find out that she studies chemistry, sharing, "People are always like, 'It's strange. It's weird. I don't get it.' And you're like, 'No, no. You can get it, too. It's not like only the special weirdos can get it. Like, you can, too, if you try.'" She also acknowledged that many of the students did not care about the course. She recognized that, for many of them, this would be their last experience with chemistry and they would not go on to use the topic in their careers. She stated:

> *All my students were students who do not really care about chemistry, you know? Like, quite frankly, they had to take the class because it's part of their curriculum for whatever it is […] But I think that in getting to know them you can try to make things more relevant to them. And they receive the information much better when you say like, "Okay, I understand that. You'll never use acid-base chemistry in your life. However, like, this is going to make you a better problem solver. And in the long run, these tools are useful to you whether or not this concept directly is."*

Leah acknowledged that students may not have cared about the content, however, she wanted them to have an appreciation for the skills that they would learn from taking the course.

Many statements from the students provided a perspective on how this course influenced their perception of the topic of chemistry. One of the respondents from Dr. Steve's course evaluation explained, "I have a chem tutor and go to SI sessions and am still doing poorly in this course. I have always liked chem until I came to this course." It appeared that the work required for this course turned the student away from chemistry.

Table 4.1. Affective/Self-Reflective Codes. This table provides an overview of the different codes under the affective/self-reflective theme and how the definitions differed between the student and TA codebook. *Italicized* definitions were not used for coding, but were parent categories of applied codes.

Theme/Code	Student Codebook Definitions	TA Codebook Definitions
Affective/Self-Reflective:	*Statements that highlight emotional components of taking the course and experiences/perspectives that influence student/participant approaches to the course*	
• Attitude/Perception:	Statements that identify opinions directed towards chemistry, chemistry courses, and the agents associated with them	
• Effects of Prior Experiences:	Statements that reflect how past events have influenced the participant's approach to the course	
• Goals and Objectives:	Statements that allude to personal goals for the course, recognition of the reason for the course and course components, recognition of the usefulness/relevance/ benefit of the course and course components, and/or attribution of value to the course or course components	Statements that allude to perceptions of students' personal goals for the course, the reason for the course and course components, the usefulness/ relevance/benefit of the course and course components for students, and/or attribution of value to the course or course components
• Culture:	Statements about how the customs and social institutions of a particular social group influence how a student might perform in the course.	
• Emotional perspectives:	Statements that reflect underlying emotional influences during the course (e.g., I liked it, I hope others don't suffer, It was hopeless, it motivated me to....)	Statements that reflect underlying emotional influences of students and/or the participant during the course (e.g., I liked it, I hope others don't suffer, It was hopeless, it motivated me to, I was stressed about my OP/research/etc. ...)

During the focus group, many students reflected on the course with a similar contempt and expressed that it made them dislike chemistry. Megan and Chelsii in particular used the word "hate" to describe their disdain, while Harold and Ashley were more hesitant to use such strong words.

Ashely argued, "I don't know. Chemistry has always been really interesting to me, and I excelled at it in high school, which is why I was crushed by this, but I feel like - since this was just one aspect of chemistry - like organic chemistry *[...]* I'm just like, 'How could I not do well in general stuff?'" Because Ashley had a good experience with chemistry in high school she was hesitant to say that she disliked it entirely. She was simply upset with the results she was getting in this course.

In the focus group, Harold shared that it left a "very sour taste." He went on to explain that the course seemed to be an "outlier." He described, "High school chemistry was my favorite science, all four years of high school. *[Gen Chem I]*, great class, entertaining, excellent. *[this course]*, I think it's an outlier, cause it was just so poorly executed. *[...]* I'm calling it the outlier, cause it's not fair to base this on my view of chemistry, going forward."

He maintained this perspective in his interviews and even compared it to other flipped courses that he had taken prior to this course. He explained:

> *It's more of, "I've had four years of classes, and this is the outlier that's none like the other." Even if I had them back to back, my* […] *[flipped] Calc I and Calc II. Even if I had them back to back with this Gen Chem II, I still think I would have the same thoughts because I really liked those with the format, and this was just, it just wasn't there.*

For Harold, there seemed to be something about the way that the flipped style was executed in this course that made it difficult for him, since he enjoyed the format when it was applied to his calculus courses.

He continued:

> *This was the outlier for us.* […] *It's just this class was that bad taste in your mouth. I think it's akin to that ... Have you heard of Bitrex? The most bitter substance on earth?* […] *it's not even that it makes you sick. It just makes you repulsed, so you're not swallowing bleach. But that's what ... Maybe too graphic, but that's what it felt like.*

Harold returned to his analogy of bitter taste and explained that the class was an outlier with regard to his experience in chemistry, but it still left him feeling upset about it.

In her interview, Chelsii stepped back and acknowledged that the course seemed to be an outlier for her too. However, she maintained her fierce disparagement of the course, explaining, "It was such an outlier. If it was based on this class I would absolutely hate chemistry. I would change my major. I would change my career of interest because it was so horrible." She lightened up, however, when she reflected on the course compared to the first-semester course. She considered, "Maybe it made me not like general chemistry as much because that was my last semester of general chemistry, but then looking back at *[Gen Chem I]*, I really did enjoy learning the stuff." After her frustration from the focus group subsided, she considered the subject of chemistry in light of her other experiences and came to a similar conclusion that Harold did.

Megan also stepped back from her statement in the focus group. She acknowledged, "It made me really ... Hate is a very strong word, so I would say it made me really dislike General Chemistry. But this semester of taking Organic has changed my opinion overall of chemistry. But I would say, I don't know, I would probably take back that I hate chemistry." She, like Chelsii, disliked the course, but admitted that it should not be the only basis for her opinion of chemistry.

When asked about her perception of chemistry, JoJo explained that it made her feel "unsure." She shared that she was, "really scared of chemistry since high school," but the instructor's passion about the subject made her, "want to be passionate too." She had difficulty with the course and would not say that she liked the topic, but she did enjoy the instructors and found the experiments and demos to be interesting.

Pete provided a perspective that seemed to invert the perspectives of others. He enjoyed the structure of the course, but admitted that he did not think of the subject as something fun. Pete explained, "I wouldn't say that chemistry was fun, but I enjoyed learning the material more. But I wouldn't be like, 'Hey, I'm bored. Let's go do some chemistry.' But I definitely looked forward to the classes at the end of the week." He looked forward to the fun he could have in the course, but it was not the topics that were interesting to him.

Pete continued this idea and shared that the flipped course helped to improve his perspective on chemistry. He remarked:

Because of the [flipped course] *I would say I have a more positive view towards chemistry. Being able to have fun in the classes definitely helped me appreciate chemistry more, and it helped me associate it with a positive feeling rather than the negative feeling and the stress that came with the traditional, for me. In that aspect, being able to associate chemistry with something positive was the biggest thing for me.*

Pete confessed that he had a better perspective of chemistry as a result of this course, since he was able to associate it with something positive. When asked what he felt when he thought of chemistry, he replied, "Just ... Not fun. It's still work, for me." Pete was under no illusion that the topic of chemistry was inherently fun, but as he mentioned previously, the course helped him associate it with more positive feelings.

As one might expect, the instructors had an influence on how students viewed the topic as well. Despite her negative feelings of the topic, Megan admitted, "*[The instructors]* made me really like chemistry. *[…]* Dr. Bradley was very enthusiastic about what he was teaching and stuff like that, and that made it more exciting for, I think, the other students and me as well." Even after all of the negative feelings she expressed about chemistry and this course, she recognized that she enjoyed the instructors' passions and associated that with the subject.

Isabella also voiced her feelings about chemistry and the influence of the instructors. She explained, "I liked it. *[…]* All the experiments made me very interested about what *[the instructor]* was saying, but I don't know if that would be enough for me to like what I was doing outside of class. I think I needed more motivation than just experiments." Even though she enjoyed the instructors' passions, Isabella still felt that there was still a piece missing to motivate her appreciation for the topic.

Overall, students did not particularly enjoy this course. They did, however, acknowledge that it was an outlier. They found different features that made the course interesting and identified others that exacerbated their frustrations.

4.2.2   Participants' Goals & Objectives for the Course

The code g*oals and objectives* is defined as statements that allude to perceptions of students' personal goals for the course, the reason for the course and course components, the usefulness/relevance/benefit of the course and course components for students, and/or attributions of value to

the course or course components (see Table 4.1 for definitions). The ideas that emerged from this code related to the purpose for taking the course and the usefulness of the concepts and activities.

When asked why they chose to take this course, most of the students referred to it as a requirement for their major or a prerequisite for their career goals. Chelsii explained that she "needed *[these courses]*for med school," and said, "I wouldn't have graduated on time if I didn't *[take it]*."

JoJo shared the same concern, explaining, "I wanted to go to med school right after graduating."

Ashley expressed a similar motive, saying, "in pre-vet you kind of need *[this course]*," and "I just needed to get it out of the way, 'cause I was already a semester behind."

Max, explained that "It's a requirement. Major." And Harold said, "It was just something that I ... Just something I had to get done with. *[…]* I just wanted to be in and out like a normal college student. *[…]* Gen Chem II, it was just one to check off."

Even TAs recognized that this was one of the main goals that students had. Leah, a TA, observed, "All my students were students who do not really care about chemistry, you know? Like, quite frankly, they had to take the class because it's part of their curriculum for whatever it is they're engineering or animal science or whatever." She was aware that most of her students were not interested in learning and were only there to check off another requirement.

Ultimately, the students' motivation for taking the course was that it was another thing to "check off" the list in order to get to where they wanted. Ashley shared, "I don't really care about it at all, I was like, 'It's a class I have to take.' I'm not that passionate about it, but who cares?"

Harold, however, provided another reason for taking the course, that was different from the other students. He said, "I'm never going to deal with half those powdered metal solutions the rest of my life. So to have that, just to have fun with it, that was very rewarding, and it was a fun time." He expressed that one of the reasons to take a general chemistry course was to gain experience doing tasks that he thought were interesting, but knew that he would not get the chance to do again.

Ashley, also, articulated an alternative outcome for the course. She shared, "it helped me learn a lot of better ways to study. Like, I studied for eight hours straight." While the content was not an important aspect of the course for her, she recognized the benefit of learning better ways to study, and the time required to accomplish those studies.

When they discussed the concepts from the course in general, some of the students commented on the idea that chemistry played a role in all sciences. When asked about the relevance of the course, Megan remarked:

> *I think some of the acid-base chemistry, I think I will have to know that in further career stuff, but I'm not so sure. I guess certain parts that relate to the human body or medical things, yes, but the majority of class, probably not, I wouldn't think. But chemistry's everywhere, so I think it's the foundation of science.*

Megan recognized a specific concept that she anticipated needing to know for her career and acknowledged that chemistry was a central and foundational science, that could be seen everywhere.

JoJo also admitted the importance of the content for her career goals, although she had to convince herself of it. When asked about the contents' relevance, she explained:

> *No I mean chemistry, .. I mean in bio it works, but we don't need a lot of chemistry. In biology I just feel… Yeah, of course in medicine and stuff, yeah it is relevant. What am I saying? […] okay chemistry is relevant, I give it that, but like medicine and stuff, yeah it makes sense.*

At the beginning of her reflection, JoJo presumed that biology was relevant for medicine, but chemistry was not. As she continued to describe it, she realized that chemistry was obviously relevant and recanted her original statement.

Pete commented on the usefulness of the content as well. He shared:

> *Personally, I think there's definitely ... Not necessarily every, every day applications, but stuff that's going to casually pop up. […] Whenever somebody will mention global warming or ocean pollution, it's always going to make me think of chemistry now. That's something that I definitely learned. I can't necessarily apply it, if I was talking to someone about it, but it's definitely always going to pop into my head. Like, "Oh. I've learned about this. If I really wanted to, I could give a detailed or an arguable explanation about it." […] And I can understand it more. Like, if on the news, they brought in the expert analyst to talk about something, I can actually understand what he's talking about, to an extent.*

Pete explained how this course helped him to become a more informed citizen who can understand and potentially respond to world events.

This was also underscored in the TA, John's account of the beginning of the semester. He shared that the instructor emphasized that there were two goals in the course. He asserted:

> *There's two goals. […] The secondary goal is to teach you general chemistry as it pertains to all these, equilibrium, acid base, et cetera. The primary goal is to make you a productive member of society no matter what field you go into. To make a happy, well adjusted, prepared person after you leave Purdue.*

According to John, the instructors acknowledged that the content was a means to a more general ends. The content was a medium in which the students were given the opportunity to develop their skills as *productive members of society.*

Chloe, another TA, shared her perspective on the practicality of the course content as well. She claimed:

> *It teaches you how to ask questions. It teaches you how to think in a certain way and then, "Oh my goodness, you have to go up in front of people and share what either you know or what you've learned." That is life. That's very necessary. […] You don't need to know how to titrate to be an electrical engineer. You don't need to know how to titrate to be a nursing student. You don't need to know how to titrate to be a math student. You don't need to know how to titrate to be a physics major. Even language arts, you do not need that, but we like our students to be well rounded and that's a part of being well rounded. I think in a sense it's also trying to teach students like, yeah, you don't really need this course but if you can learn it, that shows me that you can learn new things.*

Chloe highlighted that learning to think, learning to present, and demonstrating an ability to learn different topics was the purpose of courses like this. She acknowledged that many students in the course would not actually use the content in their futures, but that the skills they developed as they worked with the material would be essential for life.

Finally, Leah, also expressed an understanding of this as well. She stated, "I understand that. You'll never use acid-base chemistry in your life. However, like, this is going to make you a better problem solver. And in the long run, these tools are useful to you whether or not this concept

directly is." She reinforced the idea that it was not the content, but the skills that were developed that were the useful aspects of the course.

While he understood the relevance of the course material, Max expressed his frustration with the way it overlapped with other courses he was taking. He said, "Yeah, yeah. I can say it's a lot, a lot relevant. Huge relevant, but I hope that this *[course]* is ... I'm taking it together with Thermodynamic class, so it's repeating a little bit. If I can take this class earlier, it work better." He felt as though the repetition of the material was a waste of time, but he also acknowledged that if he had taken this course earlier, then it would have been better.

One of the most prevalent goals for the course, was getting a good grade and keeping up GPA. During the focus group discussion, some of the students were furious about their final grades and their effects on their GPAs. Chelsii started the dialogue with, "My GPA got ruined from this class."

Megan joined in, "It just stinks, because we can't do anything about it. My GPA will forever be impacted by the grade that I got last semester."

Megan came back to this later in the discussion and said, "It really stinks that our grade doesn't get changed at all, after this."

Chelsii added, "Yeah, we're carrying that until ... your GPA goes on your resume, even after college."

Megan continued, "I have to retake *[this course]* in the summer, and so it stinks that the class was so bad, and we get penalized for it."

Ashley concluded, "They should just raise everybody's grade by a letter grade."

Throughout this dialogue, the students did not express a concern about learning. It was all about the grade that they received. In her interview, Ashley explained, "GPA's all that matters right now," and went on to say, "We're just here to get degrees, not really work for them." She continued to highlight the idea that these classes are about passing them, not necessarily learning in them.

At the end of the course Ashley shared, "I looked at my grade once, and I was like, 'Oh, I passed. I'm good.'" She expressed that she got what she needed to move on, and that was all that mattered.

The TAs also expressed an awareness of their students' grades and how the course may have affected them. When asked if she believed her students benefited from the course, Leah commented, "Yes, definitely. Whether their GPA benefited from it or not is a different matter."

The students acknowledged many different goals and objectives for the course. These ranged from just another course to check off the list on their way to their degree, to becoming an informed citizen with the ability to engage with science in society. Overall, the focus of the students was on getting a good grade and maintaining a good GPA.

4.2.3   The Role of Culture on How Students Approached the Course

The code *culture* is defined as statements about how the customs and social institutions of a particular social group influence how a student might perform in the course (see Table 4.1 for definitions). The ideas that emerged from this code related to the students' experiences with the roles of different cultures in the classroom.

A potentially obvious cultural difference in the classroom was the influence of different languages. When it came to working in groups, Chelsii expressed the concern that "not everyone in the group understands the same language."

Isabella shared about her firsthand experiences with English as her second language. She explained, "I'm not from here, this is not my first language. I think expressing myself in another language, since my basics in Chemistry are in Spanish, so explaining that, I also have a hard time." It was not necessarily that she did not understand chemistry. It was the fact that her chemistry knowledge was rooted in Spanish, and trying to communicate that during group work or presentations was difficult for her.

Two other student participants expressed their prior experiences with learning in another country and how they brought those expectations with them to college in America. JoJo commented on how the expectations of time spent on coursework in America were different from her home country. She shared, "I come from a very different education background because I came from India. So, there's a completely different background. It's always like it's here you have to study almost every week. There you just need to study before the exam and you'll be fine." JoJo was used to being able to study before the exam and do well in the course. Here, she discovered that she needed to be studying every week in order to keep up with the demand of the course.

Ashley communicated another experience from her home country that differed from her experiences in America. She explained:

In sixth grade when I moved to India, they teach you there that ... Because there's a lot more calculation and math that goes into everything there [...] they don't really care that much about units until the answer, and when we get to the answer, the answer has to be in a square or circles, right? So, it's easy for them to find. And then, they just look over our working. So when I got here and found out that every single step, you have to put the units in the numerator, in the denominator, when you're multiplying, every single thing, that threw me off, [...] And I'm pretty sure I lost points on some of the free response stuff, which is fine because we're in America, so that's the way we're supposed to do it now. But there's a lot of international students in chemistry classes. Like, a ton. And so, I feel like it would be a little bit better if they were more lenient with that just because the thing that does matter in the end is the answer.

While I would hesitate to say that this practice is rooted in cultural differences, it is important to acknowledge that Ashley had not experienced it until coming to America. She had been told throughout her education prior to college, that the answer is what is important. Now that she was in a college course, the instructors were telling her that the process was the important part and she found herself losing points because she had trouble shifting that mindset.

Ashley concluded this idea, explaining, "It would pay to be more open-minded about that type of stuff, because a lot of us come from different backgrounds, and that comes with different learning styles." She was sensitive to the different expectations that students from different backgrounds can bring with them. She wanted the course to provide the space for those different backgrounds to be acknowledged, rather than penalized.

The customs and practices that students associated with their cultural background made conceptual changes difficult for students. Some of these students were faced with ways of doing course tasks that were different and even counter to what they had become accustomed to in their previous communities. Other students faced hardships because they had previously learned the foundational material in a different language. These cultural backgrounds influence the ways that some students approach aspects of the course.

4.2.4   The Effects of Prior Experiences on How Students Approach the Course

The code *effects of prior experiences* is defined as statements that reflect how past events have influenced a person's approach to the course (see Table 4.1 for definitions). The ideas that

emerged from this code were similar to the culture code, but had a broader definition. While themes related to culture still emerged under this code, they will not be presented again in this section.

Students brought a variety of different backgrounds and expectation to this course. With regard to chemistry itself, Ashley and Pete both expressed an aversion for chemistry based on past experiences. Ashley shared, "I'm really bad at chemistry, and *[general chemistry I]* I had to take twice."

Pete explained, "I've never been good at chemistry, so it's always been a little ... It's always come harder to me than the other sciences and maths. I would probably say chemistry, in general, it's just work." Both Pete and Ashley had experiences that led them to believe that they were not good at chemistry, which they brought with them to this course.

Pete was actually taking this course for a second time, because he did not do well the first time. When asked if he thought that his past experience gave him an advantage, he spurned the idea. He commented, "I would say no. There was maybe one topic that I had enough knowledge from the past semester to really help me at all. I didn't do very well the first time taking it." Pete did not believe that this prior experience had an influence on his improvement in the course.

Some of the TAs shared that some of their students were also retaking the course. Susie conveyed that these students would either say "Oh, yeah. I've seen this before. I actually get this now," or, "Oh, this is my second or third time seeing this, and I still don't get it." It appeared to Susie that students repeating the course might benefit from having a prior experience with it, but not all of them did.

An issue that was common amongst some of the student participants, had to do with the use of units during problem solving. The students explained that during the course they would get marked down for not including units in their problem solving process, even though they wrote the units with the answer at the end. Chelsii claimed, "I've taken multiple classes that use units. Like physics and math we even have some problems, in previous chemistry classes and my biology classes. You just have to know the end unit."

Harold remarked, "Coming from engineering where you're crunched for time. You get the right answer, good. You get units, good for you."

Ashley provided a longer description about what she had become used to as well, explaining:

When I got here and found out that every single step, you have to put the units in the numerator, in the denominator, when you're multiplying, every single thing, that threw me off, and I was like, "I'm not gonna remember to do all of that." And I'm pretty sure I lost points on some of the free response stuff.

Each of these accounts illustrated a habit that these students had developed from previous courses and experiences. They were upset that they were being penalized for something that they claimed to have learned previously.

With regard to activities that students were used to doing, JoJo expressed her frustrations with the used of open-ended questions. She alleged:

The last three questions I think it was two questions, last two questions were so highly weighed and you had to like write. We're not used to it. We're used to MCQs [multiple choice questions] *now a days. So, I don't know. It was just like the questions that we had to do, conceptual questions, it was a little harder than the rest of them and they were so highly weighed that you could not screw up and I always used to screw up.*

She was not accustomed to these kinds of questions, and the fact that their points were weighted as heavily as they were, caused her to score lower than she felt she would have if they were all multiple choice questions.

Harold commented on the fact that he was used to traditional lecture formats. He remarked, "I like the lecture format. I'm paying to go to college. I've been so accustomed to drilled 50 minute lectures." He went on to explain how the short lecture videos were difficult for him to keep up with because he was so used to these drilled lectures. This may have been a result of the speed of the course content, which he discussed later in his interview. Harold expressed how difficult it was for him to be a senior taking a 100-level course. He explained, "It's the disconnect between moving a thousand miles an hour in your major, and then having to transition with freshman in something that's like, 'And. Then. We. Multiply. By. Avogadro's. number.' It's like, I need to move a little quicker here."

Harold, also recounted an experience in the course, where a previous experience with his dad influenced how he approached a problem on E-85 gasoline. He described:

The E-85 because ... I'll go off on a little bit of a tangent. My dad has a drag car, and with the amount of boost you're running, you need to find an alternative fuel than regular 93 to run high enough boost to not have the engine retard timing due to knock, so you have two options: You have E-85, and you have leaded fuel. Leaded fuel, very expensive, but it's not hydrophilic. You have E-85, extremely hydrophilic. You leave that in the tank, you're looking at a lot of water after a week or two. So we've decided to go the leaded route, and to stay away from the E-85. But I had done numerous calculations with race E-85, which is actually E-90, so 90% ethanol. It comes in five gallon jugs. It's just very passionate to me. I'm very passionate about that topic. And being able to transfer that in the classroom where I'm looking at the back of my mind at spreadsheets, and stats, and research I've done.

This prior experience that Harold had with the substance from the in-class problem, provoked him to engage with it more fully. Just before this quote, he explained that he went so far as to debate the professor on this concept and proved the professor's claim wrong.

Isabella appeared to be more influenced by a lack of prior experiences rather than specific experiences. She explained that back where she is from, the high schools, "don't understand how much we need for university. *[…]* They taught me nomenclature, we didn't get to acids and bases, stuff like that. I came here with zero, and back then they expected a lot, that I know a lot that I didn't." Isabella felt that she was expected to know more about the content, based on how the course was structured. She recognized that her high school did not prepare her with enough knowledge of chemistry for her to be sufficiently informed prior to the course.

In addition to the prior experiences with course content (or lack of content), many of the students had prior experiences with flipped or online learning whether in college, high school, or both. Those who had taken flipped courses in college referred to the calculus I and II courses that used some of the same structures as this course. In the focus group, Chelsii shared, "I did, also, *[a flipped]* calc II class, last semester, and it was online videos, you come to class and you do problems, but he would actually explain how to do the problems."

Harold also commented on this same class. He explained:

I've taken Calc I, Calc II [flipped]. *I took* [general chemistry I] *here, regular, and I took* [this course] *flipped and, what I did for calc I and calc II flipped, was I would not watch the online videos. I would go to three lectures a week, and then attend my* [flipped] *session. So, I was getting five hours a week of in person instruction, and I did great in those classes. That was what I really*

liked, and having the [flipped] - *without the option to go to a lecture - really was horrible.*

Both Harold and Chelsii appreciated the opportunity to receive some of their instruction in person, whether that meant attending the lectures from the traditional version of the course or having the opportunity to learn from the instructor as he reviewed the in-class problems.

Megan brought up an experience from high school where she took a class that she described as being "student-taught." She explained:

> *During high school, I had one course. I can't remember what subject it was, but it was sort of like a student-taught one. And I had found that it was more successful for me, and it was nicer that you wouldn't have to go out into a study group outside of lecture when you'd be in the study group during the recitation. And it usually helps me to bounce ideas off of other people. And so that's why I thought I'd really like the class. And it was something different too because I do like Chem, but it's not my favorite class in the world, I guess. I thought that having a change of pace would be more interesting. And then it was either taking* [flipped] *that semester, or waiting a whole other semester, and so that also factored into my choice as well. I didn't want to wait that long either, but I was excited about the* [flipped] *class.*

Megan's past experience with a "student-taught" course left her with positive feelings for "flipped-like" formats of learning. She came to the course eager to participate.

The experiences students brought with them to the course, influenced their engagement. Their prior experiences created a framework through which they seemed to view the course. These expectations that they brought to the course made learning more difficult when teaching did not occur the way they wanted it to.

4.2.5   Underlying Emotional Influences that Students Experienced in the Course

The code *emotional perspective* is defined as statements that reflect underlying emotional influences of students and/or the participant during the course (see Table 4.1 for definitions). The ideas that emerged from this code were similar to the attitude/perception code, as well as some aspects of the codes under the relations theme. While these ideas still emerged under this code, they will not be presented again in this section.

During the focus group, Megan and Ashley expressed how they felt during the course. Megan explained, "It felt like they *[the instructors]* were just testing a theory, and it didn't really matter what grades we got, just to see how the class worked."

Ashley replied, "I know, we were like test subjects, and I feel so used."

The effect of this feeling is unknown. It is important, however, to acknowledge the fact that these students felt like test subjects in an experiment where the researcher was not concerned about the study's effects on the subjects.

Some students expressed how their motivations were influenced during the course. JoJo shared, "In the beginning it was all good. I was understanding and stuff," but as she continued to get less and less points she explained, "The lesser points I used to get the more, I don't know, unmotivated I used to feel. You know what I mean? Like each time I used to do bad I just used to feel like what's even the point of doing it? So, it was bad." As she continued to struggle in the course, she found that she had less and less motivation to actively participate in the course. She described the effects of this, saying, "In the beginning I got so demotivated that I just lost interest in it. That was pretty much it." The demotivating experiences pushed her further towards amotivation in the course until she could not see the point in putting in the effort to do well. In the end she admitted, "I like the structure. I think a motivated student would have done way better than I did."

During a period of time when she felt like she was improving in the course, Ashley recalled, "It motivated me just 'cause I could see that I was doing a little bit better." However, as the semester progressed she began to lose her motivation.

Ashley also expressed how the exams influenced her motivation. She explained that the final was separated into two parts and she did not do well on the first part. She indicated that, "if you fail the first part of an exam, you're kind of de-motivated for the rest of it."

In addition to Ashley's experience with the final, Megan shared her experiences with the tests in general. She lamented:

> *I didn't do well on the first exam* […] *But then I think, "Okay, what can I do differently?" This is where I branch off and try different study habits. I would do that and try something different, and then that wouldn't work, and I'd be like, "Okay, well, I'll try this." And that didn't work. And so I would try to change what I'm doing, and it just didn't do anything, so it's frustrating.*

Megan tried to find ways to improve in the course and when each attempt provided the same result, she got frustrated.

The TA, Leah, saw these frustrations in her students and felt that part of her responsibility was to "be their cheerleader" in these moments. She described:

> *Every student has a very different thing that they need from you. And so for some students, I just needed to be their cheerleader. You know, like they didn't believe in themselves that they were ever going to succeed at chemistry. And so for those students it was way more important for me to celebrate any small victories that they had. And when they weren't getting something, try to make it as simple as possible without being like, "How did you not know that?" But taking it more as an approach of like, "Look, you've done this a million times. You got this."*

Megan, Ashley, and JoJo, all expressed a need for a TA like this. Leah, took it upon herself, without having had the training, to be this for her students.

Students also described the pressure they felt regarding different aspects of grading in the course. Megan explained, "I think the pressure of the points and your grade is on the line for how you present in these type of things really affected participation." She felt that students' anxieties regarding the grades, had a negative impact on their ability to present.

The pressures of presenting were also recognized by the TA participants. Leah recalled that when students were chosen to present, "They're like, 'No, I'm not ready.' Like, 'I can't go.' And then they get nervous about it and then they're just like basically copying down what they already wrote down *[…]* They never have the time to process what they did."

Chloe sympathized with the her students and explained:

> *I can understand their frustration with it because they're learning things for the first time and they're gonna probably trip up and they're not gonna, I don't know, get enough sleep the night before they have to do a recitation and they have to answer all of these questions. All of a sudden they're up in front of that board and they're having to like do things for their table so that they get the amount of points they need in order to pass the class. They should know that those points aren't as big of a deal but in that moment*

Some of the TAs shared that they, too, "did not like the presentations." Leah went on to explain, "I don't like making my students uncomfortable, quite frankly. Like, I want them to enjoy

learning and I want them to like coming to class. And I don't want them to be afraid that they're gonna have to present on something that they don't know." The TA participants expressed a sensitivity to their students' anxieties and tried to alleviate them as much as they could.

The group-oriented structure of the course also evoked different emotions from the students. Pete found the group aspect to be the best part of the course. He described, "I think the most fun for it was that I could look forward to the group work with my friends at the end of the week. *[…]* It was also another spot where I could present any issues that I had with the material." Pete valued the support he was able to get from his group members and genuinely enjoyed the opportunities to collaborate.

Ashley also expressed an appreciation for the group-oriented structure of the course from a social perspective. She commented:

> *I love people. I love being around people, so the fact that there were so many of us in that room ... I mean, I don't know. I mean, I'm sure there are ways that it could be improved. Nothing's perfect, but I liked it a lot just 'cause I could be around people, so I felt more at ease. When I'm in a classroom with the desks in lines, I don't thrive. When I'm able to talk freely among people and figure things out, that's my ... Yeah.*

Ashley loved being around people during the course. She expressed that this was a place she felt at ease. She even expressed excitement regarding the presentations, where others, seen above, found them stressful, saying, "I wish I'd gotten chosen *[to present]* more in the recitations because I only got one chance to go up, and when I did, I killed it. I did the entire problem, didn't look away from the board, explained the entire thing, and I was like, 'Oh my God. I feel so cool.'" This opportunity to demonstrate her competence stoked her desire to do it more, and she was disappointed when the opportunity did not come around again.

Megan's experience with groups, however, was supportive in a different way. She shared,

> *I think there was more support for me of people saying, "I don't get this." "I don't either." "I don't like this class." "I don't either," than support for trying to figure out the problems. Yes, I felt the closeness between the groups but it was because all of us were struggling with the class, and all of us didn't understand things or had problems with certain things.*

Similar to Pete, Megan grew closer to her group members, but she grew closer in response to their common scorn for the course. They supported each other in their perceptions of the course as something difficult and pointless.

Max had, yet another perspective on his experience with his groups. He expressed a frustration with the fact that he had difficulty teaching his peers. He shared, "Even though I enjoy *[teaching]*, I'm frustrated that I can't teach well. I am just a student right now. I think I should know about how to make things more clear, like how can I explain a large structure thing." Max wanted to support his peers, but he saw that he had trouble conveying the material in an effective manner.

Finally, students expressed frustration with aspects of the course design as well. Several students mentioned their displeasure when a new instructor was introduced in the middle of the semester. Chelsii explained:

> *I don't like having split professors.* […] *I just don't understand the point of it.* […] *as a student you're getting used to one professor and they're teaching styles, what they're gonna be asking for on their exams. Then you take two of their exams and you switch. Then you have a final and you have no idea what's gonna be on it from the first professor and then the second professor.*

Chelsii also expressed her disdain for online courses. She shared, "I don't like classes that are taught online."

Ashley expressed more specifically that she "didn't like the fact that the lectures were online."

In the course evaluations, this went both ways. Some respondents shared that they "like the fact that we get to work in groups, that was very helpful," and, "Overall it is a really good class, I like it as a hybrid instead of the normal class."

Other respondents criticized the course, decrying, "I strongly detested the fact that when I was signing up for this class the only option available was the hybrid choice and do believe this directly impacted my grade in the course," and, "I don't like the flipped classroom. I know there are good things about it, but in such a huge class, I just prefer lecture."

Students' feelings about the course appeared to be related, again, to the expectations that they brought with them from past experiences and feelings of demotivation resulting from

consistently deficient performance. The unfamiliar nature of the course made some students hesitant to engage, which resulted in feelings of inadequate performance and demotivation.

4.2.6 Summary

These results illustrated the influence that students' emotions and prior experiences had on how students approached the course. Perceptions associated with their attitudes, goals, previous experiences, and expectations predisposed students to engage or disengage with the course in different ways. Though many of the students did not like the course or course format, and viewed the course as another item to check off their list on their way to a degree, they also acknowledged that certain aspects of chemistry could be interesting. Many of the issues that students faced coming into the course were associated with previous experiences that they had and the expectations that they brought with them to the course. These perceptions had an effect on the level of motivation and engagement that students experienced in the course.

CHAPTER 5.   RESULTS: THE INFLUENCE OF DIFFERENT RELATIONSHIPS ON STUDENTS' PERCEPTIONS OF THE COURSE

The codes that highlight the relationships between students, TAs, and instructors are outlined in Table 5.1. The overarching *Relations* theme refers to any statements that highlight the participant and/or other student interactions with agents (e.g., peers, TAs, instructors, institutional agents) associated with the course. This theme is further delineated between the types of relationships (e.g. peer-to-peer) and, in coding student provided data, the ways that these relationships were realized (e.g., rapport, approachability, competency, etc.). The casual relationship dynamics (e.g., casual conversations), as well as the formal relationship dynamics (e.g., behaviors that encourage interaction) and the perceptions of different agents' knowledge all emerged as influences to student motivation in the course.

5.1   Student-TA Relationships

The *TA relations* category is defined as statements highlighting interactions between students and TAs, where TAs are graduate students performing teaching responsibilities within the course. In data collected from students, this is further delineated into approachability, competency, and rapport (see Table 5.1 for definitions).

5.1.1   Perceptions of TA Approachability

The code *TA approachability* is defined as statements that highlight behaviors that promote or deter engagement between students and TAs. The students generally found their own TAs to be approachable and encouraging. Megan, a sophomore veterinary major, expressed this best saying, "he *[TA]* was easily approachable, completely felt comfortable asking questions."

Even Chelsii, a sophomore nutrition major, who had noticeably negative perceptions of the course, reflected on her TA's encouragement to come to office hours saying, "my TA was always like, 'Come, come, come,'".

Ashley, a sophomore corporate communications major, however, had a TA who was, "great at first," but she saw a change in him as the semester progressed. During the focus group discussion, she recounted her experienced saying:

Table 5.1. Relations Codes. This table provides an overview of the different codes under the relations theme and how the definitions differed between the student and TA codebook. *Italicized* definitions were not used for coding, but were parent categories of applied codes.

Theme/Code	Student Codebook Definitions	TA Codebook Definitions
Relations:	*Statements that highlight participant interactions or observations of other student interactions with agents associated with the course*	
• TA Relations:	*Graduate students performing teaching responsibilities within the course will be classified as teaching assistants (TA). Interactions between the participant and the TA will be classified under TA Relations.*	Graduate students performing teaching responsibilities within the course will be classified as teaching assistants (TA). Interactions between the participant TA, or another TA, and students will be classified under Student-TA Relations.
o Rapport:	Statements that capture interactions between the participant and the TA that influences or illustrates the development or existence of a relationship	
o Approachability:	Statements that highlight behaviors that promote/ deter engagement between participant and TA	N/A
o Competency:	Statements that indicate perceptions of TA content knowledge and ability	
• Instructor Relations:	*Faculty tasked with running the course and performing teaching responsibilities will be classified as instructors. Interactions between the participant and the instructors will be classified under Instructor Relations.*	Faculty tasked with running the course and performing teaching responsibilities will be classified as instructors. Interactions that the participant TA witnesses between the students and instructors, or their perceptions of the instructor, will be classified under Instructor Relations.

Table 5.1 continued

o Rapport:	Statements that capture interactions between the participant and the instructor that influences or illustrates the development or existence of a relationship	N/A
o Approachability:	Statements that highlight behaviors that promote/deter engagement between participant and instructors	
o Competency:	Statements that indicate perceptions of instructor content knowledge and ability	
o Care	Statements that recognize the instructors' concern or lack of concern for the students	
• Student Relations:	*Peers are students registered within the same course as the participant. Interactions between the participant and his/her peers will be classified under Peer-Peer Relations.*	These are students registered within the same course (not just section) that the participant teaches. Interactions between the students or the participant TA's perception of students, will be classified under Student-Student Relations.
o Rapport:	Statements that capture interactions between the participant and his/her peers that influences or illustrates the development or existence of a relationship	N/A

Table 5.1 continued

o Collaborative:	Statements that highlight behaviors associated with a task that promote/deter engagement between participant and his/her peers	
o Competency:	Statements that indicate perceptions of peer content knowledge and ability	
o Responsibility	Statements that indicate a sense of responsibility to one's peers (e.g., presentations)	
• Institutional Relations:	Any function that supports the course, yet remains outside of the course itself and is provided by the institution. Interactions between the participant and agents acting on behalf of the institution will be classified under Institutional Relations. (Parent code serves as a general code for anything not capture in child codes, yet still relates to interactions with the institution)	
o Competency	Statements that indicate perceptions of an institutional agent's content knowledge and ability	
o SI (Supplemental Instruction):	*Student facilitated study sessions provided by the department for specific courses. The SI Leader is an undergraduate student who has previously taken the course, and provides additional support to the current students through peer led study sessions.*	N/A

Table 5.1 continued

▪ Rapport:	Statements that capture interactions between the participant and the SI Leader that influences or illustrates the development or existence of a relationship	
▪ Competency:	Statements that indicate perceptions of SI Leader content knowledge and ability	

we all loved him [TA]*, but then he was really mean, as the year went on. Like as the semester went on* […] *he just got really rude and dismissive, whenever anybody tried to talk to him, and at first he was all about it and be like, "Yeah guys, I can help you with this," and we all loved him. And then he was really dismissive, and we didn't even feel comfortable asking him stuff anymore.*

As she continued her reflection on her TA during the individual interview, she attributed stress in his life to this change and expressed that, "he seemed to get more stressed and easily agitated towards when we hit the middle of the semester." She shared that, "he seemed like he had too much on his mind at the end of the semester to actually be helpful, so it was kind of difficult."

This particular TA happened to be working on his oral preliminary exam, which includes an original proposal of a novel experiment that he would write, present, and defend as part of his advancement to candidacy for his doctorate. The students, however, were not aware of this detail, and therefore, his change in approachability remained a mystery to them. This TA, John, was also a participant in the TA interviews.

John did not seem to be aware of how his attitude was perceived by his students. Instead, he articulated that he tried to express an atmosphere of encouragement and availability. He conveyed pride in his attempt to be available and connected. He shared:

I'm a very email heavy TA, so I like to send a lot of emails. You know, this is happening, this is going on, go to this, go to that. I used to do a lot of help sessions, I would do like one a semester, instead of doing that, like where I'd reserve a room. Instead of that what I would do is if I ever was in the lab late, and I had like two hours to kill while I was waiting for a reaction or something. I would just send an email saying, "Hey guys, at 6:00 PM today I'll be around in through the WTHR common area if you have any questions, just stop by. I'd be happy to talk." People came. So it was good.

John did what he could to be a TA that students felt comfortable around. Despite these efforts, Ashley expressed a different perspective, described above, and believed that there were other students who felt this way, too.

With regard to student perceptions of other TAs, there was a greater sense of discomfort. When going to other TAs' office hours, Chelsii illustrated this idea saying, "I'm going to someone that I don't know. I don't feel comfortable asking questions." She also highlighted the way that the TAs made her feel describing, "Whenever I went [*to TA office hours*] I always felt awkward and

they didn't really want me there." Despite this feeling she expressed an understanding that the TAs are also students and said, "I understand, 'You're a graduate student. You're trying to do all this stuff.'" Even though she understood their busyness, their attitudes during office hours had a distinct effect on her and discouraged her from going to them to get help.

The way that TAs would answer questions also affected students' willingness to seek help. JoJo, a junior psychology major, expressed that she was actually afraid of the Head TA (described more below) because of the way that she spoke to other students. She said:

> *She* [the TA] *always used to come and again she was like an Indian professor honestly. There's nothing wrong, but she was a little harsh. Since I'm now used to professors here, she was a little harsh. She would be like, "That's not how it's done." Not nicely. She could have been a little sweeter and supportive. I was a little scared of asking her questions because she'd probably tell me in front of other people, "you don't know this." I was scared of that.*

JoJo highlighted that she was scared of being made to look dumb in front of her classmates. She did not feel like the recitation space was safe for her to ask questions.

The feeling that it is safe to approach a TA is important to students. When they feel unwanted or like they will be criticized for not knowing something, they will avoid approaching TAs for help.

5.1.2 Perceptions of TA Competency

The code *TA competency* is defined as statements that indicate perceptions of TA content knowledge and ability. Students expressed a belief that the TAs were generally knowledgeable about the topic of chemistry, but recalled that TAs regularly seemed unprepared or did not have enough time to review the necessary materials to instruct the course.

Pete, a sophomore communications major who expressed favorable perceptions of the course, recalled his experiences with the TAs, saying:

> *They were moving around the room, but they were always available and very able to explain what I needed to do. And they ... Just the way they explained it helped a lot. They were just able to always help me. So, it wasn't an issue. There was never, "Too busy." Everybody seemed to be able to*

understand what needed to be done, and the TAs were able to help everybody

Leah also shared similar perceptions from a TA's perspective. She described:

I really liked having the opportunity to work through problems with my students. Like getting on the ground next to them and saying, "Okay, where are you at? How did you get there? What's going on?" Kind of giving them the opportunity to say like, "Hey, this is where things are going wrong for us. None of us can get past this stuff."

While pieces of Leah's and Pete's satisfied recollection can be found in aspects of what other students remembered, most others shared the views of Megan. She conveyed her perceptions of the TAs' competencies in the following:

I think that a lot of the times in class, the TAs wouldn't know how to answer questions because they didn't know how to do them. And a lot of the times, they would say, "I don't know. I haven't seen these questions," or something to that effect, or at least [my TA] would say that. And so I don't know if it was either lack of preparation for my TA specifically, or if it was a lack of communication between the TAs and the questions that were going to be asked, the short-answer questions specifically, that groups work on during class. Yeah, just lack of learning on their part and learning how to do the problem and teaching us.

In one way or another, each student, except Pete, expressed the opinion that TAs did not appear to know what they were doing, or did not know how to help the students. JoJo actually conveyed how this influenced her and her peers, saying:

sometimes if you'd ask him a question, he mostly wouldn't know. I mean, it would be like he'd take so much time to think about it that you'd just give up. "Okay even he doesn't know." You know what I mean?

The fact that her TA had difficulty with the questions appeared to discourage her and her peers from trying.

TA interviews confirmed that there were several occasions that this happened, though not as often as the students made it seem. Susie, one of the TAs, shared her experiences and how she saw it affecting her relationship with her students. She said:

> *Getting the problem set right before, and not having the time to work through it. A lot of times when they would ask me questions I would really have to think about it, because I hadn't worked through the problem myself. Hesitating with responses, and not totally seeming confident with my answers discredited my abilities as a teacher, and as a chemist. I feel like they really doubted my chemistry abilities because of that.*

Not only did Susie feel unprepared to help her students, she expressed a sense that her students began to lack confidence in her competence to be a TA as a result of her not being able to work through the questions ahead of time.

TAs who tried to provide faster help, reviewed their answer keys and gave explicit steps to solve the problems, but according to Harold, a senior electrical engineering major, this was not helpful. He explained that:

> *the TAs were just relying on the solution manuals that they had gotten, and kind of working through it. Which sometimes that was what I needed, because I just needed to get through one step of it. And if they had the solution, they could get me over the hump. But it wasn't instructional. It was just verbatim, "Oh, multiply by that. Divide by that."*

As a senior, Harold recognized the need for understanding *why* he was doing something rather than just completing the task using the information the TA provided.

Surprisingly, most students did not blame their TAs for this lack of preparation. They appeared to recognize that their TAs appeared just as frustrated and overwhelmed as them. Isabella, a sophomore chemical engineering major, shared that her TA "was very helpful, he knew what he was doing, but I sense that he didn't like it either."

Ashley defended her TA's confusion saying "I don't think it was really their fault. I think they just saw them *[the in class questions]* as soon as we saw them." This idea is confirmed by Susie's example above.

JoJo, who was not a part of the focus group, also expressed a similar view claiming that "it was like he was doing it for the first time."

Megan explained it best saying, "I think that the TAs were overwhelmed, and they were more trying to help to get themselves to understand it, rather than supporting us to understand it."

It was not that the TAs were not preparing ahead of time, according to Ashley and JoJo, and it was not that they were incapable of understanding it. It seemed to the students that the TAs were competent with the material, but were not afforded the necessary resources ahead of time. This idea is examined further in the section on preparation.

Students also addressed the competence of other TAs and how they compared to each other. Megan said,

> *I think that some TAs were better than others […] I know this one TA […] I don't know her name, but they really liked her. They said she's really smart and knew everything, knew what she was talking about, was really helpful. Not everything, she didn't know everything, but yeah. Knew how to answer the questions […] I heard about her because she's such a good TA. Well, at least I heard she's such a good TA, I don't know. I think the people that said that they have good TAs had someone like her or maybe if someone had a bad TA, they had someone like mine or something. He just wasn't, he was a cool dude, but yeah.*

During the focus group they all acknowledged this same TA who they heard was better than others and a couple even mentioned her again in their interview, such as Megan did above. This TA also happened to be a participant in the TA interviews, known as Leah.

An explanation for this perception, may be found in how Leah described her approach to the course. She explained:

> *When you spend so much time on these students, you don't ... You're like, I can't let them down. Like, if I'm putting this much work into it, it better be beneficial to them and to me. And so I think that just having the time to build relationships with your students makes you a better instructor because you feel responsible for the academic and non-academic well-being of this person. They're not your student, they're a person. And you view them totally in a different light when you're able to have conversations with them. Sometimes on task and sometimes not really that on task when you go to their table. But just like getting to know them. And I think that also helps a lot with how you approach the problem solving process with someone. Because everyone kind of needs to approach things a little bit differently. And I think that having a sense for each student's personality helps a lot. Some people are quick to get frustrated. Some are really slow to get going.*

Knowing that, it can be a huge difference maker in whether what you say will be received by your student or whether they will totally ignore it and just seek out the answer in what you said.

She expressed a concern for the student, not just as an object to educate, but as a person to get to know in the process. She also acknowledged her role as an example of the kind of effort that is expected for the class. She recognized that her students would model her behavior and if she took the course seriously, so would they. She shared:

I think it's just like the more you're able to interact with your students, the more they kind of ... You know, you feel obligated to do a really good job for them because you know them as people and you like them as people and you want them to succeed. And when they see you putting in all the work, they want to put in work for you. Like it's a mutual respect thing that really I think like amps up the experience for them.

In addition to the personal side, she also described how she responded to questions when she did not know the answer:

I would say, "Alright. You got me. But I'm gonna look this up, or you know, work it out on my own. And then either come to my office hour and we'll talk about it or I'll send you an email." I typed up a lot of emails going like, "Okay. Here's where we weren't on the same page. And now I think this should smooth things out."

Even when preparing for the session, Leah took steps to avoid being caught off guard. She described this process saying:

I would usually sit down before ... Like, once the problems were given to us, I would just look at the problem, not look at the key that was provided at all. Just sit down, go through the problem, and then I would kind of ... So once I worked through it my way, I would look at how it was worked through on the key. And 90% of the time it was basically identical work. But sometimes it wasn't, you know, and so that helps you to realize like, "Oh. As with any problem, there's more than one way to get to the right answer." […] I think not looking at the key and kind of doing it my way first helped me to be more ready to see, you know, either of the things that students could bring to me and have problems with. Rather than if you just go by the key, then sometimes you see something and you're like, "Oh." You're like thrown off by it. You're like, "What are you doing?" But really like maybe it's the way

> *that you would have done it anyway. So I would try to just make something*
> *very organized.*

Leah clearly took her responsibilities seriously, making sure that she understood what the students would be experiencing and following through with unfinished lessons.

On the other end of the spectrum was the Head TA who JoJo discussed in the previous section. Each of the students experienced this TA for brief moments throughout the semester. This TA was not assigned to a particular section, but instead moved between groups to help facilitate the recitation, similar to the instructors. In the preceding section, JoJo described her as "harsh." During the focus group the students discussed their experiences with her, as well.

Megan began the commentary saying, "She kind of confused me, a lot."

Chelsii immediately validated Megan, describing, "She confused me, more than helped me, cause she would just scribble all over the board. You can't read it, and then she's not explaining it to you, she's writing it down."

Harold expanded upon this with, "She would just tell you that you were wrong. That's what I got out of *[TA]*, she would not explain. She would just say, 'Wrong,' write something, walk away."

Megan concluded the discussion with:

> *If we got the answer right, she would come to us and kind of correct some*
> *things, and then give us a what-if situation, but the question that she then*
> *asked, as a follow-up, was very confusing, and it didn't help anything. And,*
> *if we had asked her a question, she wouldn't answer our question. I honestly*
> *don't know what she would have been talking about, anytime we asked her*
> *a question. She just didn't answer our questions.*

According to the students, this TA did not contribute to a safe or constructive learning environment. She seemingly discouraged it in some cases, as was seen in an account from JoJo in the section on approachability.

Although students felt that their TAs were frequently unprepared, they did not attribute this to their efforts. Much of the TAs' behaviors frustrated students, but the students continued to believe that most of the TAs were competent with the material.

5.1.3 General Interactions Between Students & TAs

The code *TA rapport* is defined as statements that capture interactions between students and TAs that influence or illustrate the development or existence of a relationship. Students were noticeably sensitive to their TAs' emotions.

In the section on TA approachability, Ashley is quoted explaining how her TA's attitude changed during the semester. She continued discussing the effects that this had on her, her classmates, and their approach to the course saying, "we were just like, 'What do we do? Does he hate us?' So, we all walked on glass around him for the second part of the semester *[…]* It was just kind of like we didn't feel as close to him as we did at the beginning of the semester." The relationship that was described in the section on TA approachability, shows the initial connection that this TA made with his students. Here the negative effects of his distancing and the uncertainty that the students experienced are expressed. Ashley, in particular, appears to have internalized this change as her and her peers' fault.

In an experience that appears to have strengthened the bond between students and TA, Harold described that his TA made the labs fun, but there was one time after the first exam came back that he and his fellow classmates were frustrated. He recounted this story saying:

> *I mentioned the lab about how kind of the bad kids,* [student] *and I were in lab, but she made it fun. I think she did the best she could. After the first exam, I think* [we] *kind of took out our frustrations on the exam on her, and she was like, "Listen guys, I've got a rubric I follow. This is nothing on me. I just follow a rubric." And after that, it was, "Okay. We're on the same team here."*

His TA explained what happened and why it happened, which appeared to have alleviated the acrimony that was being focused on her.

Most of the claims students had about their TAs during the recitation time, conveyed a generally positive view of their TA, but also illustrated the TA's apathy to the purpose of the sessions. Comments such as Harold's, "She was very passionate about chemistry," and Megan's, "He was a really chill person," were usually followed with remarks about indifference. Harold went on to explain, "But I just don't think that she was thriving in an environment that she enjoyed either. I think we were all just struggling there together."

Megan even goes so far as to claim that her TA disliked the course, claiming:

I got the sense that he was feeling kind of like we were feeling as far as disliking the structure and his end of it. He wasn't doing anything to alleviate it, but he wasn't egging it on either. He was just kind of there, but some comments that he said made me think that he's kind of like ... Didn't really like his situation either.

Earlier in her interview she actually describes a presentation she was giving and how disengaged her TA was with the process. She recalled:

I went up and presented something that I just wrote, or that my group just did, my TA wouldn't really say anything. He would be like, "Yeah, that's fine." And then I'd just sit back down. So I wouldn't know, "Oh, I did this really well, or I really did this right, or there's something I could have improved on, or units, or anything like that."

Ashley described a similar situation in regard to working on the in-class questions. She shared:

I don't think he really facilitated discussion much. He didn't seem to really care if we talked to each other or not. Yeah, he never really seemed to get us all together and get us talking or have us discuss anything […] he helped, but he didn't seem to care about the group aspect of it.

Her TA was there, but not actively facilitating the intent of the sessions.

JoJo sums up this feeling by sharing, "My TA was just never there. He wasn't there. […] It felt like he was never there. That's all I'm trying to say. He may be physically there which we never noticed because he was not saying anything."

The accounts from the TAs who participated in interviews, however, do not portray the same perspective. The TAs all described their roles as active participants in the flipped learning sessions. John described how he would ask questions during each presentation to get students to think more deeply about the problem. Susie and Leah both described how they were always moving from table to table trying to connect with and help their students. Chloe gave a specific example where she helped a student with a thermodynamics problem. She explained:

During the thermodynamics portion of the course, where they did delta G and delta H and all of those kinds of things, they would have issues of, "I

90

don't know what equation to even start on," and I would be like, "Okay, well, let's write out all of the equations. Now tell me," like if they had an issue of Delta H because there's delta H of formation, delta H, all the other ones. […] I was just kind of like, "Okay, which one to you use if something is vaporizing, which one do you use for if something's a liquid," and I would have them draw things out so that they would see for themselves exactly which equations they need to use. It was almost like a tunnel kind of thing, where I would start big and then go small and usually they answer their own question of, "Oh, it's this delta H," and then off they go.

Chloe explained how she actively led students to answer their own questions rather than giving them explicit answers.

Max, a junior materials engineering major, generally enjoyed the course. He did, however, have frustrations with the way his TA engaged in this process of making him answer his own questions. He shared one interaction he had with his TA and the frustration he experienced with it, saying:

She was good. I ask a lot of question when doing lab, three questions focused on every lab, and she answers them, clearly know the problems that I … Yeah, I think she was good. I like a straightforward answer instead of ask me to think why this should be this way, that should be that way. I think that's what [TA] likes to do. They ask you to think why this is that way. If I know why is that, why do I ask? Sometimes I just missing one small part in the thinking, though.

As a part of their training, the TAs were directed to respond to student questions with other questions in order to make the students think deeper about the problems and discover the answers to their own questions. Max is clearly frustrated with this technique and this is one of the few times that he expressed dissatisfaction with the course.

Chloe, however, shared, "We were specifically told not to answer student questions actually with answers or walk them through how to do it unless it's at the very, very end." Max, may not have been aware of this.

Not all accounts of student-TA relationships were negative, though. Pete, who had a generally positive experience in the course shared, "I don't know how other recitations felt about it, but with *[TA]*, they were kind of fun, honestly *[…]* I had a lot of fun with *[TA]*."

JoJo also shared "the good part was my TA. Every time I screwed up he always, after the exam would tell me what I did wrong and stuff." She expressed an appreciation for her TA's efforts to help her during the course.

TAs also shared positive experiences they had with their students. Leah's account, in particular, displayed the kind of fun that she cultivated in her section of students. She began:

> *I feel like my students and I had more fun than any of the other recitation sections. Like, I don't know. I was always like cracking jokes with my students and we had a good time. And like lab was fun. Like I said, people were like competing with one another to see who could do it better, faster, get the best percent error. Or, you know, whatever it was. Like they were doing things that made it more fun for them. And so I think that it was less of a chore almost. […] Sometimes you go next door to ask the TA next to you something. Like, it was a different environment in that lab compared to mine. It was much quieter. People had their heads down. And they were probably more focused, which maybe isn't the worst thing. But, I don't think the atmosphere was one to like excite learning. It was more like, "Okay. Get in, get your stuff, get out. I don't want to see you any longer than I have to. Whatever." And I hope that my students never, ever felt that from me. Like, I never want them to feel like, "Hey, get out of here." Like, "I have more important things than you." Like that is something that I never wanted my students to feel.*

Leah recognized the benefits of a focused classroom, but she believed that it was more important to create a space that *excites learning*. As she was one that caught the attention of students from other sections, I would claim that she may be on to something, since students clearly care about their relationships with their TAs.

The various interactions that students had with their TAs, influenced aspects of their approach to the course. When TAs were transparent about the reasons for their actions, students responded positively. However, when students did not understand why their TAs did certain things, they were left frustrated.

5.2   Student-Instructor Relationships

The *instructor relations* category is defined as statements highlighting interactions between students and the faculty instructors (whether directly experienced by a student participant or witnessed by a participant TA) or perceptions that the participant has of the instructor. In data

collected from students, this is further delineated into approachability, competency, care, and rapport (see Table 5.1 for definitions).

5.2.1 Perceptions of Instructor Approachability

The code *instructor approachability* is defined as statements that highlight behaviors that promote or deter engagement between students and faculty instructors. Being able to feel comfortable approaching an instructor for help was a topic of significance for students.

Students expressed an appreciation for being able to ask questions without fearing that they may be made to feel dumb. Chelsii recalled going to an instructor's office hour to ask a question that she felt that she should have known. When she asked, she reported that "the explanation that *[the instructor]* gave made it very clear, didn't have any judgment of, 'Oh, you don't get this? Why don't you understand this?' Or have some expectations that you understand exactly what's going on in the course and you understand all the higher level stuff that they know." She was relieved to find that the instructor was understanding and nonjudgmental.

Throughout Dr. Steve's course evaluation, he is lauded for his patient, friendly, and positive persona. The respondents described him as "easy to talk to," "always smiling," and "very approachable." One respondent explained, "I just felt comfortable with him during the recitations and always enjoyed the videos he uploaded." Only one respondent claimed that, because Dr. Steve "was not as talkative or outgoing as Dr. Bradley in class, I was slightly intimidated when he came over to my table during class to help or to see how we were doing." Even so, overall, Dr. Steve was recognized by the respondents as someone they felt comfortable interacting with, academically or otherwise.

While the students felt comfortable asking for help from the instructors, actually getting the help seemed to be a different story. Megan shared, "as far as getting help from them, it was a little bit more difficult because it'd feel like the class was here and they'd just be over there doing, I don't know, watching, facilitating." She felt that many times the instructors were not accessible and explained:

> *As far as the professors coming around, I think he would come around every once in a while, but he would ... I think, the tables on the end had more access to him and then also, now, once we got Dr. Bradley or Dr. Steve to help us with this question, it'd be so helpful. Then I'd be fine. But it's getting*

them to ... It's almost like sharing one professor with everyone else at once, and every table has questions. And so what would happen was usually when my table had a question, he would not be available for a really long time, and then all of a sudden it'd be the next question and we couldn't ask because we'd have to try to figure out the next question. I think that kind of goes along with why people had mixed feelings about the professor.

Megan's frustration with the course really emerged when she expressed her inability to receive the help she needed. In the section above on TA relations, Megan, shared that her TA was not as involved with the learning process, and here Megan illustrated how much she relied on the instructors to help her. She clearly valued their knowledge, but because there were so many students, her access was limited.

Chelsii shared the same frustration explaining, "Each one of us wanted to ask him a question and I bet four out of the eight people would've gone up and asked him if he was available." She also wanted to get help from the instructors, but she did not feel as though they were available enough to help.

Pete on the other hand, felt that he was able to get access to the instructors whenever he needed it. When asked if he felt supported by the instructors, he shared:

Without a doubt. They were moving around the room, but they were always available and very able to explain what I needed to do. And they ... Just the way they explained it helped a lot. They were just able to always help me. So, it wasn't an issue. There was never, "Too busy." Everybody seemed to be able to understand what needed to be done.

Pete valued his access to the instructors and felt as though he could reach them if he needed.

The students relied on the instructors knowledge as a way to succeed in the class. While they felt comfortable asking the instructors for help, most of the students found it difficult being able to access them for that help.

5.2.2 Perceptions of Instructor Competency

The code *instructor competency* is defined as statements that indicate perceptions of instructor content knowledge and ability. Overall, the students acknowledged that the instructors were effective at communicating the material and clearly knowledgeable of the course content.

They did not, however, feel that the course structure was sufficient for the instructors to meet their potential as teachers.

Throughout Dr. Steve's course evaluation, he is celebrated for his passionate and clear explanations. One respondent explained, "Dr. Steve was passionate about the subject and showed that in his teaching. Also he was always willing to answer questions and if his first explanation was not clear he would find another way to explain it so that it did make sense." Another respondent shared that he "has a unique talent for explaining things clearly and in ways I had not thought of before." Only one respondent claimed that, even though they liked Dr. Steve and thought that the was "very knowledgeable," they felt that "he expected way too much from the students of the class." Despite this comment, overall, Dr. Steve was recognized by the respondents as a passionate, knowledgeable, and effective instructor.

Most student participants in the study felt the same about the instructors. As Pete described in the preceding section, "They were moving around the room, but they were always available and very able to explain what I needed to do. And they ... Just the way they explained it helped a lot. They were just able to always help me."

Ashley also shared that any time she felt confused, "I would go to the professor and I'd ask him *[…]* he'd always guide me in the right direction."

With a little hesitation, Megan explained, "I think they were really helpful, although only whenever I would ask for their help, so if I called them over during class and they needed to explain a question or something. Dr. Steve, Dr. Bradley were very helpful." She clearly valued their assistance, but was, again, frustrated by the fact that she had trouble getting ahold of them.

JoJo provided a detailed account of her perceptions of the instructors' effectiveness. She began:

> *I liked the way how Dr. Bradley and Dr. Steve used to teach, but with Dr. Steve, if you go to his, what's it called, office hours, he's an amazing professor. He teaches you everything and stuff. But when he's in the class, I don't know, his voice or something, it's a little really mellow, so it's not that audible and he's not really in public. If you go to him privately he will teach you really well. So, that's awesome. And he gives us hints before. He doesn't solve questions for us but he gives us hints so that he directs us to the right direction. So, that's pretty cool.*

While she had her qualms about Dr. Steve's ability to instruct in a large setting, she distinctly recognized that he was an exceptional teacher in smaller settings and valued that ability. She continued comparing the instructors during the in-class problems:

> *when Dr. Steve came he actually it was a little more beneficial when he came around. But Dr. Bradley was really fun but at the same point in time he would go, I don't know, table hopping. And he wasn't paying a lot of attention. I don't know. He was really beneficial but at the same point of time it wasn't. It's hard to explain it. Words. (laugh) […] It's truly hard to explain. He would still help but he didn't pay much time to it. Do you know what I mean? He would just solve one question but what about the rest of the five people on the table? That's what I'm talking about. Dr. Steve on the other hand he would ask every student almost. "You got it? You got it? You got it?" That was really helpful.*

In this second part of her account, she explained that while Dr. Bradley was a lot of fun, he would not stay at a table long enough to help the students as a whole. Dr. Steve, on the other hand, made her feel as though she could get her questions answered before he moved on to the next table.

Chloe, one of the TAs, provided an explanation for why Dr. Bradley may have appeared to "table hop." She explains, "He would say, 'Let me start you off,' and then, he'd leave. He'd never give them the full on answers." The "table hopping" was his way of leading the students to their answers without giving them the answers.

A more negative perspective comes from Chelsii who simply said that, "They didn't teach."

Harold expanded upon this in the focus group discussion with, "Short-answer for what we've come up with: yes they walked around, no they weren't helpful."

He continued in his interview saying, "I think their hands might have been tied with the university because they really can't articulate much more than what they're allowed to do in that short setting. They're looking at just those problem sets. They're looking at the time they have, and if it's meeting once a week, I think their hands were tied."

Later on, he even said, "I don't think it was the professor because looking back on it, they did all they could." Harold saw the instructors' passions and experienced their knowledge, which led him to believe that it could not have been their fault that he did not have a good experience with the course.

Megan reiterates this idea in her interview. While explaining her frustrations with the course, she clarified, "it's not them, it's the structure of the class."

Later on, however, Megan claimed:

> *The professor wasn't supporting us because they weren't giving us the foundation we needed to learn these questions because the students would have to give the teaching during the class, rather than the professor giving us what we needed to be successful on the exams. It's like stepping stones to get us to be successful on the exams. I guess, if that made sense.*

She decided that, despite how much she liked them, the instructors were not supporting her enough to assure her of their competence.

The students acknowledged that the instructors were knowledgeable of the content. However, many of the students concluded that the instructors were unable to support them in the ways that they needed because of the structure of the course.

5.2.3 Perceptions of the Instructors' Concern for the Students

The code *instructor care* is defined as statements that recognize the instructors' concern or lack of concern for the students. As should be expected, students seemed to value caring and involved instructors. The importance that students placed on the efforts the instructors made was apparent.

Ashley remarked how seemingly simple things did not go unnoticed to her. She described,

> *they* [the instructors] *just kind of went in circles around the entire thing, and whenever they made eye contact with somebody, they'd go in and be like, "Hey, do you need anything?" They wanted to help. Nobody asked for them to help at all, and it kind of sucked, so I used to talk to them whenever I finished problems and stuff. I think they just really wanted to be needed.*

Ashley saw the genuine effort that the instructors put into making the class work, and she appreciated it. She even said, "I know the professors want us to do well, especially in this course, because they were great."

In Dr. Steve's course evaluation, the respondents explicitly highlight that he "cares about our learning," and "cares about the students." One respondent explained, "It is very obvious that

Dr. Steve cares about his students and how they do in the class, and I appreciate this." The respondents recognized that Dr. Steve cared about them and they valued that.

Harold was particularly impressed with the instructors' liveliness during the morning session. He noted:

> *They were very awake for 7:30 in the morning, which I've had plenty of classes, 7:30s. You could see the professors who care, and the professors who are like, "I need to get to my research after this. We've got something going on." These guys were there. They were in it to win it.*

Harold was grateful for the instructors' vivacity that early and their dedication to the students. He recognized that they had other responsibilities in addition to teaching, and he appreciated their commitment.

Harold, however, goes back to describing how the instructors' "hands were tied." He explained:

> *the instructors were quite great. I felt that they really cared. They really wanted to put it in there, but their hands were tied with the format that they were given. I feel like their passion would be able to be articulated a lot better, if it was a normal classroom setting. Because they both seemed like very passionate people about chemistry, it was just shorted in this classroom sense.*

Harold saw their passion and believed that they cared, and he concluded that they could not have been the reason for him not having a good experience with the course.

Megan repeated this perspective, sharing:

> *I think their intentions were success, I don't think any Purdue class would set people up for failure. It feels like that sometimes, but I think that they meant well, but the structure of the class did not set us up for success, not the way it was taught.*

While initially not blaming the instructors, Megan eventually put some of the responsibly on them. She explained:

I think they wanted the class to work so bad that they didn't see what wasn't working. And that may have showed in the averages, that may have not shown in the averages, but they did have good intentions I will say. I do not think the professors are at fault, except for, of course, making the structure.

She still maintained that her experience was not entirely the instructors' fault and that the instructors had good intentions. She did, however, place responsibility for the course structure on them, which she described as the reason she did not have a good experience. This is further explored in a later section.

Students recognized that the instructors were concerned about them. They believed that the instructors wanted them to succeed and were doing what they could to help them make that happen. However, the students maintained that the course structure hindered that, whether it was the instructors' fault or not.

5.2.4   General Interactions Between Students & Instructors

The code *instructor rapport* is defined as statements that capture interactions between students and the instructor that influence or illustrate the development or existence of a relationship. The importance that students placed on the casual conversation with an instructor, or for the efforts the instructors made to interact with the students was evident.

Overall the students expressed a deep admiration for the instructors. Even in the midst of their frustrations in the focus group, they shared how much they liked the instructors. Ashley gushed over them, saying, "I loved the professors. They were the most adorable, they were so sweet." Later on she focused on Dr. Bradley specifically, claiming, "Dr. Bradley was the most precious. *[…]* he was like our class grandpa, everybody loved him so much."

The group continued her account, starting with Isabella, who said, "He made jokes that my dad did once."

Ashley reiterated, "He's the cutest thing ever."

"He had 'Days of our Lives' in his lecture videos," remarked Harold.

"He's incredible," replied Ashley.

Max recounted, "Dr. Bradley was so nice, one night I was struggling on a homework question and, it was 9:00PM, I sent him an email."

"And he replied?" Ashley asked.

Max answered, "Yeah, at 10:00PM."

Through this dialogue, the students praised Dr. Bradley in particular, simply for his personality. Max, however, brought up a specific event that only increased their appreciation for Dr. Bradley. During his interview, Max added to this account. He explained, "I send him email, he hand write a solution to me. It was awesome." He was astonished that the instructor took the time to, not only respond to his late email, but to hand write an explanation as well.

So much of Dr. Bradley's applause came down to his enthusiasm. Student after student made similar observations about this trait. Isabella cheered, "I loved Dr. Bradley's enthusiastic and everything."

Megan claimed, "Dr. Bradley was very enthusiastic about what he was teaching and stuff like that, and that made it more exciting for, I think, the other students and me as well."

JoJo shared how Dr. Bradley's passion influenced her. She stated, "He's really passionate about chemistry. *[…]* It makes me want to be passionate too."

In addition, Pete remarked, "Dr. Bradley was a ... He's a character. We joked. He was like a dad. He was very friendly, I felt, and liked to make jokes."

Pete also described his interactions with Dr. Steve, whom he had as an instructor during his previous attempt at the course. He explained:

> *Dr. Steve. Yes. I had him for* [this class] *the first time I took it as well. I didn't very well get to know him the first time I took it because he was literally just lecturing at us. I felt I got to know him a lot better, which helped. He teaches differently from Dr. Bradley, but I felt just having the recitations with him helps me with his lectures, just because I understood his approach more. I wouldn't say that there was too much difference from* [this class] *in the way he taught ... The traditional version versus* [flipped]. *But just having that added interaction with him helped me with his section of the course, because I know, for a fact, when I first took it, the sections were more of the ones that I struggled with.*

Pete believed that his ability to have these interactions and make these connections was a vital part of his improvement in the course from the first time he attempted it.

In his course evaluation, Dr. Steve continues to be commended for his genuine interest in the students' learning. One respondent explained, "During recitation he will stay and explain until

we understand what the question is asking and what to do." Dr. Steve's patience and commitment to the students' learning seemed to be the trait that students' most valued in him.

Some specific events were highlighted by the students that illustrated both positively and negatively perceived interactions. Harold was particularly excited about an opportunity he had to "prove the professor wrong." He boasted:

> *It was great because he was doing the ethanol vs octane presentation. He was trying to make the point that ethanol was better, but octane was more power-dense. And I threw the wrench in his plans that ethanol served at the gas station was served ... Ethanol at the gas station is E-85, 85% ethanol, 15% octane. And once you add that 15% octane, you get back to a normal energy density, and it actually is advantageous. So I had done my full calculation with the 85 percentage instead of the 100 percentage. That was like my highlight of the class. I proved the professor wrong. […] He didn't feel the same passion I did about telling the rest of the class about it. He kind of just consulted with me. He'd be like, "Okay, this is a little bit beyond what we were trying to get at, but."*

This was the highlight of the course for him. He was disappointed that it would not be promoted to the rest of the class, but he understood that it was beyond the scope of the course.

There were a few times, however, that Harold did not understand the decisions of the instructors and got frustrated. One account in particular was with regard to grades. He went to the professor to understand why he did not get some points and shared this account:

> *on that first exam I did have all the answers right. And went to his office hours, and he goes, "If you'd like to get a re-grade, you can submit it for a re-grade." I'm like, "I don't want a re-grade. It's right." I'm like, "Can't you do this?" "Oh, no. The TA has to re-grade it." "Aren't you the professor?"*

He could not understand why the professor, could not just override the decisions when he saw that it was clearly correct. This was one of the events that left him with a negative view of the course.

Isabella was generally positive about her interactions with the instructors, however she felt that the instructor was not as interested in her group. She had her session during a time when the students were spread across two rooms. As a result, the instructor would move back and forth

between both rooms. She expressed, "I understand why the professor wasn't very invested in my class, we were a few people in comparison to the other class." Later on she shared:

> *He did ... It was very enthusiastic, and the enthusiastic thing really sticks with you, but I didn't have a lot of communication with him since I think he focused more on the other class than in my class. We didn't see him more often ... Like, he helped us a couple of times, maybe three times at most, and he was very good explaining. He explained it really well and then we understood when he left.*

Isabella valued the passion and knowledge of the instructors, but because of the nature of the rooms, she was unable to interact with them as much as she would have liked.

Overall, Ashley expressed, "we all got along really well with them," and Megan mentioned, "They made me really like chemistry."

Further along in the interview, however, Megan commented on the abilities of the instructors. At this point she was upset with the course and the way the instructors conducted it. She declared, "I'm sure if I had the right teacher, then I think that I would enjoy it more probably because for me, it's all about the teacher. If it's a really easy class and I don't have a good teacher, then no."

When I brought her attention to her previous statements about liking the instructors she replied, "Yeah, but they didn't talk very much during class! If they would have talked during class, then yeah." This ultimately was about the course structure, which is discussed more in the sections below. She wanted more interactions from the instructors in a more formal lecture setting. She did not feel as though she was learning, because the instructors were not "talking."

JoJo's greatest grievance about the interactions with the professors was their lack of encouragement. This is not to say that she found them discouraging. She simply expected them to be more actively encouraging. She explained, "they weren't like, 'Hey you can do it.' It wasn't like that. I just feel the science courses at Purdue, I just feel the professors need to motivate us. *[...]* Somebody needs to show *[the students]* belief."

Overall, the students liked the professors and enjoyed the casual interactions that they had. JoJo summed it up nicely, saying, "the professors were good. Both of them had completely different personalities. One of them totally extroverted, one of them very introverted. But both of them had a unique way of teaching. They were good teachers."

5.3 Student-Student Relationships

The *student relations* category is defined as statements highlighting interactions between students or the participant TA's perception of students. In data collected from students, this is further delineated into collaborative, competency, responsibility, and rapport (see Table 5.1 for definitions).

5.3.1 Perceptions of Students Regarding Collaborative Activities

The code *student collaborative* is defined as statements that highlight behaviors associated with a task that promote or deter engagement between students in the course. Given the flipped nature of the course, there was a greater emphasis on student collaboration. As one would expect, there were groups with members that did not like each other, groups with seemingly smarter students and less smart students, and groups with students who simply did not want to work together for a variety of reasons. This led to a spectrum of different perspectives when it came to collaboration.

First, there were those who truly enjoyed the group work. One of the respondents in Dr. Steve's course evaluation simply said, "I like the fact that we get to work in groups, that was very helpful."

Isabella shared a similar perspective, "I like working in groups, I like learning from my teammates." She went on to describe how she did not like them changing groups, but appreciated that she was able to still have one person from her previous group in her new group. She explained,

> *I would have liked to stay with my first group. I don't know, we just felt so comfortable with each other, and then they changed me, and I'm like, "What?." Then I ... I kind of... There was one girl and me, after, in the second group we stuck together, I don't know why. It was good, and I know a lot of people now and if I need help, they were awesome,*

In this account, she also highlighted her appreciation for the friends that she made as a result of this structure.

Pete also expressed his appreciation for the how the groups worked. He expanded on what Isabella shared and described how being assigned groups helped to facilitate the discussion, as

opposed to the way *normal* courses provided the *option* to work together when there was time available. He explained:

> *That gave me the support of the other people in my class because we were put into groups right from the start, instead of in the other version where you're in recitation, and it was sort of like, "Do it on your own or do it with a group of people." And when you don't really know anybody in the class, you're not likely to necessarily jump in and be like, "Hey, let's do this together." But being put in the groups definitely made it easier to work with people.*

Pete went on to share:

> *me and the other students were working on the questions together. So, that definitely helped me because there was five different minds doing that one problem, and each giving their ideas, and explaining how to do something, or another way that it could be done.*

Pete valued having other minds that could support him and he embraced the opportunity to learn alongside them.

Those who had issues with working in a group usually ascribed those issues to other students' inabilities to teach or plain lack of knowledge of the content (examined more in the next section on competency). Chelsii explained, "there's some students that I guess know what's going on and they don't teach you and that's what is expected in these courses."

Megan shared an example of this from her group where she did not think it was fair that the one person who understood what was going on, was responsible for making sure everyone else understood too. She argued:

> *the one guy who understood what he was doing from an AP Chem background I guess, or who I encountered in the groups, it was almost their responsibility to stop and teach the whole table what we didn't understand […] so I think that it was kind of unfair for the person who knew everything because they would be the ones stuck teaching the people who didn't understand. And everyone learns at different levels, so if he explains something that made sense to me, then the other person at the table might not understand, or maybe a couple people don't understand and then he has to spend his time explaining how they did the problem, whether they understand it or not. Which I guess, in a sense, is what the purpose was for*

104

everyone help explain how to solve the problem, but I don't think it was fair for that one person or maybe two people at the table to have to figure out and make sure every person was getting the problem so you're grade didn't get affected when they had to go present.

Megan did not think that the responsibility for teaching should be placed on the students. She believed it was the instructors' responsibility as she described in the section on instructor relations.

Megan also displayed her understanding of the intent of the course in this quote. Early in her interview she also shared:

I think that the learning was meant to be in a group because you're problem solving together and trying to figure it out together, but over half of the table wouldn't contribute. There'd be one quiet one who just wouldn't say anything. And then me, like the other groups, who couldn't say anything because we didn't know the answer. Or I would kind of help, but overall, there was no learning, I don't think, because no one could contribute anything to learn, I guess. Except for that one person who actually knew what he was doing,

Megan recognized that deeper learning was supposed to occur during the group problem solving. Nevertheless, she identified that there appeared to be too much of an obstacle in the students' foundational understanding of the material for that to happen.

Max, who did well in the course, shared a specific example of the difficulty he faced when trying to help another student. He reported,

I was trying to help people, though, but […] even if you know the knowledge, you're not a good teacher. I guess I'm not that good to teach them. I can say this times this equals this, that times this equal to this, this times that equal to that. He says, "What? What was this? What was that?" I think they just don't know the material. They didn't do the homework, so they don't understand we haven't talked RT times lnK is the equation for Gibb's free energy, standardized condition. I say, "R is this, T is that, K is this times this ..." blah blah blah, "you put RTlnk, is it equal to G." He said, "Wait, what was K, please?" I say this, this, this. "Why is K is chemical equation," blah blah blah. I say, "Okay, now you have G, because you know everything." "Wait, what was G again?" It's make me feel sad.

Max tried to help his peers, but he had difficulty accomplishing it and even felt that he was not capable of accomplishing it.

Megan also attempted to help another student early on in the course. She described:

> *It was just balancing equations, to me, simple things. And I was just going around making sure every person at the table understood what we were doing. There was this one girl who could just not get it. I was like, "It's okay. It's supposed to be teaching table. We're all learning." I was trying to keep her caught up, but she just was not getting it. And then she didn't speak up when she said she wasn't getting it. We made it to the end of the problem, and she had nothing written down, but originally, I thought that they had told us, this may or may not be true, that the single presentation from your table would affect all of our grades at the table as far as participation or something like that. And so it was, at least in that moment, it was up to me to be able to make sure she got the problem and make sure I understood it.*

Megan tried to help, but this peer was not speaking up about not understanding it. Later in the interview, Megan explained how as the semester progressed she began to feel safer in SI than in the class session. She shared:

> *SI is voluntarily, so whoever goes there is willing to learn more and wants to learn how to do things. I think that aided in participation and input, and suggestions, and stuff like that. Rather than, I guess, it was an early class, early recitation that morning so maybe people weren't as talkative or didn't want to put input. But I felt, I guess, safer putting my input in in SI than I did in recitation.*

Megan recognized that peers who attended an SI (supplemental instruction) session (see section on Institutional Relations) needed help too. She felt as though she would not be judged there.

Those who understood the in-class problems were also reported to be domineering. JoJo explained:

> *I mean in my group there was just one smart kid. Maybe two. Plus they were so dominating that even if you tried they'd be like, "No, that's not right." And I was like, "Okay fine then you do it." And then they would just grab the board and just start doing it and then like, "We're done with the question." And just keep talking. And they'd be like, "You understood right?" And out of the five people I would be the only one who did not and I'd be like, "Yeah, I did get it. It's fine."*

106

JoJo's experience connected to Megan's in that she did not feel comfortable expressing a lack of understanding in her group.

TAs noticed both the existence of overbearing students and other students' fear of speaking up. When comparing the flipped and traditional courses, Susie, one of these TAs, observed, "This one was more collaborative you could say, although it's usually a dominant student leading the conversation, and then others just sitting there. You can tell they don't know what's going on." She witnessed what JoJo was describing. There were students who dominated the discussion and the rest of the students just watched.

Leah, another TA, made an observation regarding the students' fears. She claimed that sometimes "I think that people are often afraid to voice those *[questions]*."

JoJo also expressed how important it was to have the right people in your group. She remarked:

> *Honestly my group members, I never liked them. Yeah, I did not like them. There was just one girl I used to be with. So I never sat in my group. I always sat with her because she used to teach me. So, it was better. But she was always so busy outside the class. So, I had to sit with her and she used to teach me. She's a really nice person so that worked out. But I think I only got a C because of her. I would've gotten a D. It's really important to get the right people.*

Ashley's account of group work, while still representing a disparity between those who know and those who do not know, also illustrated some group engagement. She described, "All of us were mostly just sitting around, and fooling around in class and waiting for one person to do it, and then they'd just teach us unless I actually knew, and then I'd be all over the place doing it." She explained that there was usually just one person doing the problem, but acknowledged that others, herself in particular, also embraced the problem, and once it was solved, the group as a whole would try to make sense of it.

Max shared a similar report of his group, saying, "There are people, half of the group know how to solve the problem. Sometimes I don't do the problem. This is finish the problem, and I talk, we discuss a little bit, then we play cellphone." He and his group were able to work on the problem, but when they finished they were off task playing on their cellphone.

For those who made the decision not to collaborate, Chelsii provided the explanation that academia is competitive by nature and therefore it did not make sense for them to collaborate. She reflected on the in-class problems, explaining that:

> *you'll teach your friend or whatever, but that same student is competing for what you wanna go into. They're gonna compete for those slots in the med school. They'll be competing to get higher curve of the class. They're gonna be competing to graduate with whatever distinction. Everyone in the school, the whole entire thing is a competition. So, how do you distinct yourself enough to stand out? If you're relying on someone that's gonna teach you, but they just wanna be better than you. Why would they teach you? Unless you're like a close friend and you see, "You're struggling, but I get it. Then I'll give back whenever I don't understand something and you do."*

Chelsii felt that the collaborative nature of the course did not make sense given the competitive nature of college. However, she also shared how a group that was close to the board helped her when she was giving a presentation. She explained, "I've had like the table that was like close to the board would always help me because my table's too far away to even contribute to the conversation. *[...]* the table like knew. I was like, 'Hey, I need some help.'" In spite of this perception of the competitive nature of her peers in college, she still found that they would help her complete her task.

Regarding those who did not collaborate, the TA, Susie, described a perspective that assumed less malicious intent. She explained:

> *I had a lot of students that didn't like it. They didn't like how they were always forced to work in groups. Some students work better alone. I noticed...They're supposed to always write on the little whiteboard on their table, but a lot of them liked to keep their own notepads. A lot of them would be writing stuff and doing work in their notepad, and then eventually present it to their group. Whereas to support the style of how the TAs are walking around, they're supposed to have all work on the whiteboards, and be talking about it constantly. A lot of students didn't like that aspect that they had to constantly be communicating with one another, and couldn't individually think*

It was not that the students were trying to hide their answers from their peers, it appeared to this TA that they were more comfortable thinking on their own before trying to discuss it with their peers.

JoJo summed it up nicely with a couple of "pros" and "cons" for the group oriented sessions. She claimed, "pros are if you do that around the table and stuff it is really helpful for kids but at the same point in time if the people in your group that not interactive and stuff, and they just don't care, they just want to do their own thing, they don't want to help other people, they're not going to do it. So it's like a con for other people." She acknowledged the benefits of having multiple minds working on a problem. However, she also recognized that these minds all had to invest in the task or it would not be productive.

5.3.2   Perceptions of Students' Competencies

The code *student competency* is defined as statements that indicate perceptions of student content knowledge and ability. The collaborative nature of the course was supposed to provide opportunities for students to teach each other. However, there appeared to be a belief that there were too many students who did not understand the material, or the few students who have the knowledge either did not have the ability to communicate it to the rest of them, or they simply chose not to.

At the beginning of her interview, Chelsii described the recitation sessions as being "thrown in a giant room with a bunch of students that don't know what's going on."

At the beginning of the semester, several of the students felt that they were sufficiently competent, but as the semester progressed, that certainty waned. Harold explained:

> *Earlier in the semester, I kind of knew what was going on, leftovers from 115, leftovers from what I remembered from high school, leftovers from just normal education. I was one of those people who was kind of working it through. We were working on it. We were doing it. I was interactive. […] After the second half of the semester, I was gone. I was just a kid, "Hi, I'm here."*

Harold's perceptions went from a sense of competency with the material to almost apathy. He was simply in attendance.

The TA, Leah, however, had the opposite experience with her students. She described:

In the beginning, like you just seriously have to go around to every table before they even start the problem because they don't know where to begin. And then by the end of the semester, you know, the first five minutes that they're looking at a problem, you just walk around and you're observing and they're all communicating. Saying, "Oh, I think this is what we need to do." "Oh, I think you're right, but I think we also need to" ... You know? Like they're working together and they've got it figured out. And you can just let 'em go until they run into a problem. But at first you're like, "Okay. Come on. Like, let's get you going in the right direction. You can do it." And then at the end of the semester I feel like they're so much more confident in their ability to look at this problem and find the direction that they need to go.

This is not to say that one of their experiences was more true than the other. It is important however that we acknowledge both. While one of the TAs did not perceive that her students were getting more disheartened as the semester progress, there was a student who did experience this and it is important to address it.

Generally, student participants did not perceive others, nor themselves, as capable for the majority of the course. When it came to understanding the content, Megan recounted the episode with the girl who did not understand how to balance equations. She shared, "I could tell on the first day, that girl that didn't know how to balance, that she didn't have that foundation. I'm sure it was a little bit more difficult for her to take it."

Isabella also had friends who struggled despite their efforts. She shared, "Like two of my friends are repeating the class next semester because they didn't do very well. They had good organizations and good work methods."

Max reflected on his perceptions of others' abilities and attributed their lack of understanding to a lack of effort. He explained, "I think why they didn't like that class, because when they saw one problem that they did not understand, they didn't read the book, they didn't do the practice questions, and they didn't prepare enough for the exam." He believed that if they just put in more effort they would understand.

Upon further reflection, however, Max realized that many people in his group were putting in the work, but still could not understand it. He shared:

I think it's weird that people in my group in [this course]*, they did the homework, but they know nothing about the topic, it's really weird to me, though. How is that possible? The homework is, I think it's hard enough for*

you to know the topic. Even if you Google online, questions thing, you still have to understand how the questions to be set out, so you can put in your numbers, work out the problems to get a solution. It's really weird to me. I think maybe this just didn't do the homework thing. I don't know.

Max finally concluded that some people were just naturally better at chemistry than others. He came to this after he compared a friend of his to one of the girls from the focus group who had described all of the different things that she did to try to succeed in the course, yet still did not meet her goal. He remarked:

She did every question, every single problem on the class. She will write notes. I don't even write notes for the lectures, video lectures. I don't write notes for it. She write notes beautifully and many pages, many, many pages. I was like, wow, someone put that much work? My friend, my another friend, he didn't do any work before exam. He just do questions, ta-da-da-da. He get 100 grade every time for every test. I was like, okay, if that's the case, probably you should ...

Max could not bring himself to outright say it. After trying to find the appropriate words, he was asked if he was trying to say that some students are more inclined to succeed in chemistry than others. He reluctantly replied, "Shoot. Yeah. *[...]* Yeah, that's what I mean."

A TA named Leah, expressed this idea a little more gently. She did not say that some students were more inclined to chemistry than others, but she did say that the students who "bought in" to the course did better. She shared, "I think you get out what you put in to any class. But this is a class where you can put in a whole lot and you can get out a whole lot. And so students that bought into the process I think will definitely look back and be thankful that they had this flipped class experience." It was not about the tasks that the students performed, but whether or not they put in the effort with the mindset that the class would be beneficial.

Leah continued to expand on this topic and described how different students appeared to respond to the course. She explained:

I had some students who really bought into the process. And for those students, I think they enjoyed the class and they rose to the occasion. They kind of knew, "This is gonna be more challenging than it has to be, but I'm gonna come out better in the long run." They ... I had ... I wouldn't say a majority of my students felt that way, but I would say a good fraction of

them did. And I think they got a ton out of the course. I had a lot of students kind of in the middle ground where they were like, "Alright. Like this isn't the worst thing and I'm learning a lot. But man, I wish this wasn't so much work." I think a lot of people were like, "Oh, this is so much work. Like, if I just took it not as a flipped class it would be way less work." […] And then some people just, you know, wouldn't watch the videos. They didn't care. They would show up to recitation and be like, "Oh, what are we talking about today?"

According to Leah, there appeared to be four different students: those who embraced the structure of the course and benefitted from it; those who were resigned to take the course, yet persisted; those who resisted the course and struggled as a result; and those who were apathetic to the course and were simply present.

The TA, Susie, shared a perception that concurred with Leah's account. She described:

I had students that really liked this flipped classroom because they were the type of students that took learning into their own hands. They were the type that would work through practice problems, and come in with questions and that sort of stuff, and watch the videos ahead of time and take detailed notes on it. Those students seemed to really enjoy having more freedom in their learning, instead of going to lecture that they already know a lot of the material on, and that sort of stuff.

Susie also saw students who appeared to engage with the course, and those were the students who did well and enjoyed the freedom it provided. Susie, also identified freshmen taking the course, who either tested out of the first-semester course or had Advanced Placement credit from high school, seemed to enjoy it as well. She explained:

I had a lot of students that were freshman that had tested into chem II, because they had taken AP chem, and then taken the AP test, and got placed in chem II. Those students were pretty fine with it. They seemed to do well with all the problems that were given. They seemed to like the style of the course. It was different than their other classes, and they found it a refreshing change.

The freshmen who were taking the course, brought college credit with them from high school, which indicated that they were most likely higher achieving students in the first place. As high

achieving students, it is likely that they enjoyed the challenges of the course and were responsible when planning how they would study.

Regarding his own abilities and the abilities of most of his group members, Max was decently confident. He shared, "Sometimes when the question is easy, my group just figured it out within five minutes, and then we were waiting there doing nothing." He mentioned a couple of times that his groups would finish the problem and then start playing on their cell phones while waiting for the class to move on to the next question.

Most student participants acknowledged that there was at least one student in their group who knew how to do the problems. JoJo explained, "I mean in my group there was just one smart kid. Maybe two."

Chelsii expressed a similar situation, describing, "We switched groups four times. So all four times, one person would understand it. One person would solve the rest of the problem, and they didn't understand it enough to explain it to the rest of the group."

Megan provided, yet another description of this, explaining:

> *I was lucky enough to have one person in my group who knew exactly what he was doing. But the problem was, he wouldn't, or the multiple people, there were probably three freshman who had taken AP Chem. They were fresh out of AP Chem, so they knew generally what they were doing. It was hard to get them to explain the problem, or they would only be the ones writing it because they were the only ones who knew how to write it.*

While they recognized the presence of peers who could help them, Chelsii and Megan expressed the same problem: these peers were not able to explain or teach the problems. This appeared to be one of the greatest setback for the student participants.

Chelsii also explained, "there's some students that I guess know what's going on and they don't teach you and that's what is expected in these courses." For those who attempted to teach her group, she described, "it is very hard for a student to be able to understand the ways to teach so that others would learn from it."

This perception was reinforced by JoJo who explained, "Other kids, they understood. They learned really well. But I could see that they sucked at teaching us because of course they're not teachers, they're not professionals."

Even Max, who enjoyed the teaching, expressed his inability to teach, saying, "I actually enjoy teaching people somehow *[…]* The fast people, explain to the slow people. Like twenty minutes, thirty minutes, they still don't get it cause we are not good teachers, we are just students."

This concept of students not being able to teach affected the student participants' perceptions of the presentations as well. Megan explained:

> *The student doesn't teach what their writing like a teacher would teach what they're writing. I think that their explanations, they wouldn't give explanations for what they're writing because they're just trying to get through the problem on the board, and then sit back down. But a teacher's job, obviously, is to teach, so their explanation, I think, would be more in-depth and make more sense than a student who might not understand what they're doing kind of thing.*

She also shared that:

> *Even the students that did understand what they were doing, they would go up and write their problem, but they wouldn't really explain very much. They'd go too fast because they completely understand it, so it's not that they expect everyone to understand it, but they just don't think about it as much, I don't think.*

Megan's accounts illustrated the dearth of students' abilities to facilitate the learning of their peers, even when they understood the content.

Chelsii added to this issue, explaining how students' handwriting had an effect on her ability to learn. She claimed, "Some people's handwriting's not as legible as others, so it just makes it more difficult."

Megan also conveyed that her peers' personalities played a role in the effectiveness of their presentations. She contended that, "there were a lot of, I wouldn't necessarily say socially awkward, but just shy people in the group who didn't want to present. They'd forget everything, get super nervous, and just couldn't present effectively or teach effectively."

Susie, a TA, empathized with this issue and even experienced a student in her section who was brought to tears when she had to present. Susie recounted, "I feel bad for some students that got called on to present that weren't comfortable presenting. I actually had a student cry on me once when she was called to present."

Ultimately, Harold explained it best, sharing that there were those who know and those who do not know. He described:

> *From talking to people, even the people in this* [focus group]*, I believe there was one gentleman who did fine in it. He was doing well. I think he had gotten an A in the class you mentioned. So he'd be on top, and I think the majority of us were on the other end, which were not As. So judging from talking with people in lab, and talking with people in the lecture, […], there was the people who got it, and the people who didn't. There was no disconnect like, "I'm a little unsure." It's like, "I have no clue what's going on." Or "What's that? That's easy."*

Harold boiled the experiences down to these two categories. Those like Max, who could not understand why others had such difficulty with the course, and those like Megan, who despite all of her effort, she could not grasp the material.

5.3.3   Students' Perceptions of Responsibility in the Course

The code *student responsibility* is defined as statements that indicate a sense of responsibility to one's peers. This emerged in association with the in-class problems and presentations that students were required to give.

In the focus group, Megan and Ashley discussed the presentations and the effects of their peers' who presented. Megan explained, "You can't say no, or else you get zero."

Ashely agreed, "I know, and then everybody else gets a zero too, and then everybody hates you. *[…]* it was so sad."

In her interview, Isabella shared that she felt bad about how she affected her group members' grades because of her presentation. English is her second language and she found that when she got nervous she would switch between her first language and English. She explained, "I would get more nervous and that would affect what I was saying. Maybe sometimes I was speaking Spanish, I know that. Sometimes I confuse English and Spanish, and then the TA will look at me like, 'What?' I'm like ... Then I have to resay it and stuff like that."

Although she enjoyed the presentations, Ashley described the traumatic experience she witnessed with one of her friends who had to present in class. She shared:

The presentations, I like them because I like going in front of people, but one of my friends, she could not walk up there because she has really bad anxiety. So, she got a zero. Everybody was really upset. So, she got a zero, and so did her group, just 'cause she couldn't go up there. And she was like, "I can't." She was stuttering, and it was a huge thing.

The presentation that Ashley's friend could not give, resulted in her group getting a zero for their participation. The group members were frustrated with this person who had the responsibility of earning points for them.

In addition to the points, student participants expressed a sense of responsibility to make sure that their peers understood the material for their own sake. In the event where Megan was helping a peer understand how to balance chemical equations, she explained, "at least in that moment, it was up to me to be able to make sure she got the problem."

Isabella shared a similar sense of responsibility for her peers during a presentation she gave. She explained that the pressure she felt was not necessarily to get the points for her group, but to make sure her classmates understood the problem. She shared:

So the pressure of they have to understand from what you're explaining, that was my pressure. Like, what if they're not understanding it and it's my fault and they didn't understand this topic? After that, they didn't explain it again, or the professor didn't do it again, to compliment what I didn't say or anything. So that was my pressure. What if they don't understand and they do badly because of this? I was just feeling bad.

Isabella felt the responsibility to educate her peers, rather than the responsibility to complete a task.

Students felt a duty to their peers to do well during the presentations. They recognized that deficient performance would result not only in a loss of points for their group, but it could also affect whether other students could learn the concept.

5.3.4   General Interactions Between Students

The code *student rapport* is defined as statements that capture interactions between the students that influence or illustrate the development or existence of a relationship. Many of the student participants and the course evaluation respondents, shared that they made friends during the course. A respondent from the course evaluation shared, "I made great friend throughout the

course but I poured more time and tears into this course than I have any other." They may have worked very hard, but the course provided them with meaningful new relationships.

Pete actually looked forward to the course and felt that he was able to make friends with the people in his group. He stated, "It was fun ... I think the most fun for it was that I could look forward to the group work with my friends at the end of the week because we did, more or less, become friends. At least every group that I had, we could always joke around and stuff."

Ashley, who was the most passionate about the friends she made in the course, shared in the focus group, "I met five people that are literally my best friends now. Through that whole discussion thing, we talk every day, we hang out almost every day, and I think that it was because of the fact that we had to sit together and talk for two hours straight." In this account, the course structure was what created these bonds of friendship, but in her interview she ascribed it to the stress of the class. She claimed, "I made good friends, and we kind of bonded over the fact that we were all dying in this class."

Harold shared a similar reflection. He said, "*[I]* definitely made friends. I took it with a friend of mine, so I think it was ... It was a bonding experience for all of us. Like a traumatic bonding ... I don't want to say traumatic, but it was kind of a bonding experience." He hesitated to call it traumatic, but he expressed that in the tougher parts of the class he found that he was bonding with his peers.

Megan also contributed to this theme, though she focused more on the difficulty of the course. She shared:

> *Depending on what group I had at what time, there'd be more support than others, whether people understood the problem, didn't, were tired, didn't want to talk, just didn't overall, didn't want to be there. And I think there was more support for me of people saying, "I don't get this." "I don't either." "I don't like this class." "I don't either," than support for trying to figure out the problems. Yes, I felt the closeness between the groups but it was because all of us were struggling with the class, and all of us didn't understand things or had problems with certain things.*

Megan's focus on the common hardships, illustrated the development of bonds similar to what Harold and Ashley described.

Regarding the development of friendships, even the TAs noticed the students bonding. John described:

> *One cool thing that I saw that I've also seen in previous sections, is a lot of friend groups were developed. A lot of visible friendships were developed from just coming together and discussing and getting to know each other, that I didn't see as much in like traditional. And it was more like camaraderie for lack of a better word.*

Leah also noticed that her students, "were having fun and they were joking and making competitions between groups like who could do things better." The development of friendships appeared to be a visible benefit of the flipped course.

Student participants also expressed a frustration with switching groups throughout the semester. Chelsii shared in the focus group, "And then we had to switch groups after every exam, so you couldn't even get comfortable with the group of people that you're with."

JoJo also shared this feeling, saying, "I just feel after every exam they should not do that anyway because you're warming up to people. You need time. So right after every exam you can't switch people. I mean you can, they did. But not the best idea I feel." She explained that because of the time it can take to become comfortable in a group, she felt that changing groups after each exam was more of a disturbance than a benefit.

Isabella also expanded upon this in her interview. However, she included the benefit of changing groups, as well. She explained:

> *I would have liked to stay with my first group. I don't know, we just felt so comfortable with each other, and then they changed me, and I'm like, "What?." Then I ... I kind of ... […] It was good, and I know a lot of people now and if I need help, they were awesome*

While she would have liked to stay with her first group, she recognized that changing provided her with more opportunities to build her personal network.

When it came to actually working in groups, Pete shared, "Being in the groups just added a relaxed ... We were relaxed around each other, so that was able to take away from the stress." He felt that the group component made him feel less stressed.

Isabella explained that she appreciated having others around her who were experiencing the same thing. She mentioned, "I like that I have people around me that are in the same place that I am."

This comfort, however, illustrated that some groups did not appropriately use the time during collaborative tasks saying. Ashley shared, "All of us were mostly just sitting around, and fooling around in class and waiting for one person to do it."

Max described similar events. He explained, "Sometimes I don't do the problem. This is finish the problem, and I talk, we discuss a little bit, then we play cellphone." Instead of using the class time to study or work on homework, Max recalled that they would play on their phones when they finished their work.

The group component of the course facilitated the development of friendships between students. While students identified different causes for the development of these relationships, they were centered around their interactions in their groups.

5.4   Students' Relationships with Institutional Entities

The institutional relations category is defined as statements highlighting interactions between the students and agents acting on behalf of the institution, specifically agents that function to support the course, yet remain outside of the course itself and are provided by the institution. This theme did not emerge in the TA interviews. In data collected from students, this is further delineated into competency, SI (Supplemental Instruction): competency, and SI: rapport (see Table 5.1 for definitions).

This theme was also used as a general code to capture comments about the students' relationship with institutional entities associated with the course. This only served to highlight custodians in the building that the classroom was held in and the chemistry resource room, where students could go to get help on their chemistry coursework.

Harold brought up the custodians and complained about the fact that they did not prepare the room for their class at 7:30 am. He said:

> *We would always have to reorganize the tables because they're open study rooms. The [...] custodial engineers would leave, and they weren't in charge of making sure that room was ready for 7:30. So we'd walk in there, chairs would be strewn everywhere. There'd be like sorority chants on the boards from whoever had the room reserved the night before, and we'd be over there cleaning up scraps of Papa John's.*

Harold did not feel that it was his responsibility to have to prepare the classroom for the course, and shared that it seemed like, "school was an afterthought."

Chelsii commented on the resource room and simply expressed, "I don't really like the resource room, but if you really had a question there is someone to ask." She may not have liked it, but she recognized that it was a resource if someone needed it.

5.4.1 Perceptions of the Competence of Institutional Entities

The code *institutional competency* is defined as statements that indicate perceptions of an institutional agent's content knowledge and ability. This code emerged primarily from Harold, who described the chemistry department's ability to run this course.

In the focus group, he explained "This is on the department's shoulders for, 'How can we actually teach this course, and make people learn?'" He placed the burden of designing a course, not on the instructors, but on the department. It was the department's job to make people learn. In the interview he described, "Whoever set the rules or set the syllabus, like the overarching" was, "where the stem of the problem comes." Here he described the department again and assumed that they were in charge of designing the course, and gave it to the instructors to execute.

5.4.2 SI (Supplemental Instruction)

Supplemental Instruction, or SI, is a program for student facilitated study sessions supported by the department for specific courses. An undergraduate student who has previously taken the course is hired as the SI Leader. The SI Leader provides additional support to the current students by planning peer led study sessions for current students to attend. The next two sections describe themes that emerged in relation to the students' interactions with the Supplemental Instruction program.

5.4.2.1 Perceptions of SI Leader's Competence

The code *SI competency* is defined as statements that indicate perceptions of SI Leader content knowledge and ability. When asked what made SI helpful, Megan replied, "The teacher. I think his name's *[SI Leader]*. He was awesome." She went on to say:

> *I guess the main denominator was* [SI Leader]. *If I had a question, he would stay after and help me specifically. He would stay after ... He would go and teach people after, outside of SI hours just willingly going to help for hours. I remember I was in WALC and he was there for at least three hours teaching these kids how to figure out these problems. I think it had something to do with him.*

Megan credited much of her progress to the work of the SI Leader.

Isabella specifically described how the SI Leader was able to effectively help the students. She shared:

> *the SI leader makes us think a lot. He's not like, "Okay, you have to do this." It is, "Well, what do you think?" We start talking about it, and it just clicks. "Okay, this is it." We try doing it, and the SI leader is like, "Yeah, that's fine. That's okay." I like that they guide us, not tell us anything, they just guide us or just say, "Think about lecture" And you start thinking about that part of the lecture, and you're like, "Oh, he said this, so we have to do this."*

Isabella saw the benefit of being directed to think through the problems. She appreciated the work that the SI Leader put into guiding them in their thinking.

These students valued the SI program and attributed aspects of their success in the course to it.

5.4.2.2 General Interactions Between Students & SI Leader

The code *SI rapport* is defined as statements that capture interactions between students and the SI Leader that influences or illustrates the development or existence of a relationship. Most of the comments surrounding this theme were in regard to the time that the SI Leader put in to help the students.

This is seen in Megan's recollection in the previous section. There was also a discussion about this in the focus group.

Megan began, "The SI leader *[…]* was very helpful with that, but he wouldn't have time to teach every student, every problem that was given in recitation."

"He stayed till midnight, were you there?" Ashley interrupted.

Chelsii agreed, "He stayed like three or four hours after his SI session, not paid, completely free for the people."

Ashley continued, "*[…]* he was great. He stayed, literally, past midnight that one time before the exam, trying to help, because all of us were a mess."

The common thread for the SI Leader was that he put in time above and beyond what was required of him, and that did not go unnoticed by these students.

5.5   Summary

The relationships and interactions that students had with different people and entities associated with the course had an impact on the way students engaged with and perceived the course itself. Although they were frustrated by the TAs' and instructors' appearance of being unprepared for the sessions, the students appreciated the obvious care that these course agents had for them. Students also valued the opportunities that they had to develop relationships with their peers during the course. However, they were unsatisfied with their peers' abilities to contribute to the learning process during recitation. Different perceptions of the relationships that students experienced as a part of the course, such as being cared for and a sense of duty to their peers, influenced their perceptions and motivation related to the course.

CHAPTER 6. RESULTS: THE INFLUENCE OF THE DESIGN & EXECUTION OF THE COURSE ON STUDENTS' PERCEPTIONS

6.1 Recognition of How the Course was Designed to Work

The codes that highlight a student's recognition of the way the course was designed to work are outlined in Table 6.1. The overarching theme of *Course Design*, refers to any statements that highlight specific components in the way the course was designed. This theme is further delineated between different course components (e.g., course content, online resources, assessment options, etc.). The components, as well as the way they are experienced emerged as influences to student perceptions of the course.

6.1.1 Recognition of the Instructors' & TAs' Preparation

The code *preparation* is defined as statements that illustrate the instructors' and TAs' efforts in preparing the course (see Table 6.1 for definitions). The student participants provided perceptions of the efforts of instructors and TAs, while the TA participants recounted the ways that they actually prepared and how they were supported by the instructors in their preparations.

According to the majority of student participants, the efforts put forth by the course staff appeared to be last minute efforts. Chelsii described, "It's like they didn't plan anything in advance, and everything was like, 'Oh, class starts. Guess we've got to get our tables put together.'"

Megan commented on the time organization in the sessions, specifically with regard to the chemical demonstrations. She explained, "I would suggest leaving more time at the end for *[the demonstrations]* because they would ... What would happen is we wouldn't have enough time to finish the problems that we're doing in class and they'd be like, 'Okay, we have to stop because we have to do this demonstration.'"

Isabella expressed her concerns about the time provided to finish the problems, explaining, "I just felt that maybe they didn't plan ahead about the time they were giving us to finish everything. *[...]* I think they had a good intention, it just ... They didn't think it through what happens if they don't get it, or what happens if they get stuck?" Isabella recognized that the instructors had good intentions for the students and the course, but they did not take the "what if's" into account. If they

ran out of time and students were still working on the problem, she felt like they just moved on to the next one.

Table 6.1. Course Design Codes. This table provides an overview of the different codes under the course design theme. *Italicized* definitions were not used for coding, but were parent categories of applied codes.

Theme/Code	Student and TA Codebook Definitions
Course Design:	*Statements that relate to specific components in the way the course was designed.*
• Preparation:	Statements that illustrate the instructors'/TAs' efforts in preparing the course
• Course Content Relevance:	Statements that identify the significance of course content and/or draw connections between course content and elements outside of the course
• Assessment Options:	Statements about tasks used to assign student grades (e.g., exams, quizzes, etc.)
• Online Resources:	Materials on the internet that are required to complete the course or can be used to supplement learning (e.g., online lectures, YouTube videos, online PowerPoint, online homework/textbook, etc.)
• Improvement Suggestions:	Statements that make suggestions or express desires for how the course could have been designed or conducted differently
• Classroom Layout:	Statements that comment on the classroom venues in relation to suitability, personal appreciation, influence on students' learning, etc.

With regard to preparation to assist with the in-class questions, the student participants claimed that many times, the TAs were unable to help them. During the focus group, Megan started this discussion when she described her experience as a team facilitator for a course that same semester. She began, "I was a team facilitator, for our class this semester, and one of the things that went wrong, that I thought, was that there was hardly any communication between the TF's and the professor leading the class, and so maybe."

Chelsii interrupted, "I think that's what happened in this class."

"Yeah," Megan continued, "The TA's weren't prepared for the problems that were given in class."

"I feel like they should have known about those problems ahead of time," Ashley contended.

Megan explained, "So, maybe have them work it out before class, and know what they're doing before they come to class, so that they can help us."

Ashley continued, " 'Cause our TA was working it out with is. He'd sit down at one table and just work it so he…"

Megan claimed, "Ours would tell us the wrong answer, and then go and tell the other table the right answer."

"My TA once told us the wrong way to solve a problem," Chelsii recalled, "and it was another group that solved it right and was presenting it, and she's like, 'Oh, I told you guys wrong, you should look at their solution.'"

Megan proposed, "You should have it ready, and checked, and ready to explain."

Chelsii acknowledged, "I understand no one is perfect, by far, absolutely no one can be perfect, and making a mistake is totally okay, but I think that they should have had the opportunity to understand the problem before they decided to teach it to us."

Megan considered, "And maybe that wasn't their fault."

This dialogue illustrated the student participants' perception of the lack of preparation of the TAs. However, they acknowledged that it may not have been the fault of the TAs. In fact, the TA participants had tried to enact the preparations that the students proposed in this dialogue, but were sometimes unable to.

In the individual interviews, this topic continued to come up. Megan shared:

> *I think that a lot of the times in class, the TAs wouldn't know how to answer questions because they didn't know how to do them. And a lot of the times, they would say, "I don't know. I haven't seen these questions," or something to that effect, or at least* [my TA] *would say that. And so I don't know if it was either lack of preparation for my TA specifically, or if it was a lack of communication between the TAs and the questions that were going to be asked.*

Harold, also remarked on how the TAs relied on the solutions manual they were given, saying, "The TAs were just relying on the solution manuals that they had gotten, and kind of working through it."

Even JoJo who had claimed, "It was very planned," also shared that "sometimes if you'd ask *[my TA]* a question, he mostly wouldn't know."

As mentioned above the TA participants were trying to prepare themselves for the sessions. TAs like Leah shared, "I would always spend a lotta, lotta time preparing for recitation for my office hours, that kind of thing. *[…]* If I want to look like I know what I'm doing and I want to be able to actually help my students, then I better know these problems inside and out before I even show up."

Susie, a TA, would watch the videos, as well, to prepare for the recitations. She described, "As a TA, when I would watch Dr. Bradley and Dr. Steve's lecture videos, I would usually speed it up because I didn't need to go super slow with it. That helped."

Leah tried to watch the lecture videos and explained:

> *Some things I remember struggling when I had to learn them the first time. And so when we would get to those units, I would go back and watch like, electrochemistry. I was like- "Oh, who likes electrochemistry?" You know? Like, I better watch the videos for this 'cause, whew, I don't remember anything. So that was sometimes part of my preparation process. But definitely always doing the problems ahead of time was how I would prepare to be the most effective that I could be.*

When it came to preparations for the problems specifically, the TAs expressed some varying recollections. John recalled:

> *For most part the questions were given well in advance. Yeah, I think there might have been a couple times Dr. Bradley or Dr. Steve were late, but yeah for the most part they did their best to give it to us* […] *the Monday of staff meeting we would get the questions for next week, usually, or at some time during that week we would get them. Usually at least before the weekend. And then we would have time to look at them, work on them, and then that Monday, we'd get the answers.*

Susie, who was assigned to the first recitation session of each week, remembered a slightly different experience. She explained;

> *Dr. Bradley started out very ambitious, but then as the course went on I felt he wasn't supporting his ambitions. I taught recitation at 7:30 on Tuesday*

morning, and since we would work on problems together with the students, it's helpful to have the problems ahead of time and 6:30 AM an email would come out like, "Here's the problems for today's recitation." It's like well, between 6:30 to 7:30 is my time to drive to campus, and eat breakfast, and get to the room, and get the whiteboards out for everyone. It isn't my time to look through the problems. I prefer to do it the night before, and work through them. That was Dr. Bradley's downfall. […] That's my perception of Dr. Bradley, is he had great intentions but maybe not the best support for the TAs to follow through with everything, especially with sending out last minute problems like that. In contrast, Dr. Steve was very on top of sending us problems. We'd get them before staff meeting on Friday, and considering we didn't teach until Tuesday at the earliest that gave us time to prepare and look through those.

Susie's account appeared to imply that this was more frequent than John realized. Susie also recognized that it seemed to be more common for one instructor over the other.

Leah highlights this point as well, sharing, "With Dr. Bradley there was more excitement in the classroom, but less like preparation than Dr. Steve." She ascribed strengths to each of them, but Dr. Bradley was less able to prepare the TAs for their jobs. She went on to affirm Susie's report, saying, "I taught the first recitation of the week, the 7:30 am on Tuesdays. And sometimes at about 6:40 am on Tuesday I was getting sent the problems that I was supposed to have looked at and know how to do." She explained that this resulted in feelings of being "more put on the spot by your students."

Susie reiterates Leah's point when she was asked about how prepared she felt for each session. She explained, "I was not prepared for Tuesday morning a lot of the time. I know my students picked up on that. They had even commented on it in my teaching evaluations too." Susie's course evaluation suffered from what she perceived to be a lack of support from the instructors.

With regard to Dr. Steve, Leah shared that it was "way more organized," and that she "always felt very prepared." She described, "We would get to the staff meeting on Friday and already have received the problems for the upcoming week. So you had plenty of time to sit down, do them yourself."

The ability to prepare, helped to set the TAs at ease. When course materials were provided at the last minute this upset the TAs' abilities to prepare, which the students noticed. This also affected the TAs' abilities to best support their students.

6.1.2 Recognition of the Relevance of the Course Content

The code *course content relevance* is defined as statements that identify the significance of course content and/or draw connections between course content and elements outside of the course (see Table 6.1 for definitions). Students expressed varied perspectives on the applicability, practicality, and significance of the course content.

Some student participants discussed the relevance of the course in light of their own experiences. When the instructor presented thermodynamics and energy efficiency in the context of fuel, Harold referred to his dad's drag car and the experience he had investigating fuel efficiency. He recounted:

> *My dad has a drag car, and with the amount of boost you're running, you need to find an alternative fuel than regular 93 to run high enough boost to not have the engine retard timing due to knock, so you have two options: You have E-85, and you have leaded fuel. Leaded fuel, very expensive, but it's not hydrophilic. You have E-85, extremely hydrophilic. You leave that in the tank, you're looking at a lot of water after a week or two. So we've decided to go the leaded route, and to stay away from the E-85. But I had done numerous calculations with race E-85, which is actually E-90, so 90% ethanol. […] I'm very passionate about that topic. And being able to transfer that in the classroom where I'm looking at the back of my mind at spreadsheets, and stats, and research I've done.*

Harold engaged with this concept at a more meaningful level because he had experience with the example that the instructor was using to illustrate it.

Pete also acknowledged the relevance of the material by looking at where he could see himself thinking about it in *normal life*. He described:

> *Personally, I think there's definitely ... Not necessarily every, every day applications, but stuff that's going to casually pop up. Like cooking, […] there's always going to be stuff that we learn that's definitely going to pop into my head when I'm reading the label on something. One thing that stuck with me was ... We spent an entire recitation time with several different problems on ... I want to say it was ... It had to do with the oceans. I think it was ... It was solubility, possibly, or something along those things. Whenever somebody will mention global warming or ocean pollution, it's always going to make me think of chemistry now. That's something that I definitely learned. I can't necessarily apply it, if I was talking to someone about it, but it's definitely always going to pop into my head. Like, "Oh. I've*

learned about this. If I really wanted to, I could give a detailed or an arguable explanation about it." […] *I can understand it more. Like, if on the news, they brought in the expert analyst to talk about something, I can actually understand what he's talking about, to an extent.*

While Pete was not certain that he would explicitly use the material in his life, he acknowledged that there were areas of his life that he anticipated thinking about the topics and understanding the material.

Other students saw the course as a foundation to build upon for their majors. They may not need to know the specifics of the content, but other classes that they will take will use the concepts to build other ideas that are important for their careers. Isabella shared her thoughts on this, explaining, "Very basic of what I'm doing. Like *[general chemistry I]*, *[this class]* are the basics of what I have to learn in organic and, you know, the Chemical Engineering classes I have to take."

Max provided a similar response, claiming, "It's very relevant to my major, so yeah, it helps me on this knowledge, help me to learn something about that."

Other student participants took some time to convince themselves that it was relevant. When asked about the course's relevance, JoJo shared, "No I mean chemistry, .. I mean in bio it works, but we don't need a lot of chemistry. In biology I just feel… Yeah, of course in medicine and stuff, yeah it is relevant. What am I saying? *[…]* okay chemistry is relevant, I give it that."

Ashley gave a similar response, explaining, "No, no. Not anymore. I mean, it would've been. Well, not ... I mean, I guess a little bit. I think organic chemistry pertains more, but general chemistry is a basis for organic chem, so it definitely ... Yeah, *[…]* It definitely would have, but yeah. I mean, that's just cause I changed." Because she changed her major to communications, she did not believe that it was relevant anymore, but had she stayed in her original major, she realized that it would have been a foundation for many of the other courses that were more clearly relevant for her.

The course evaluation affirmed these perspectives with respondents claiming, "The videos and in class questions are relevant to the real world which makes them very interesting in my opinion and I appreciate that." A respondent also shared, "Professor Steve is good at asking real-world application questions. *[…]* Professor Steve is definitely well knowledge in his area and has a lot of interesting questions that go beyond just chemistry structure textbook questions."

The TAs also commented on the "real world application questions." Leah recalled:

I really liked the example problems that both of [the instructors] *would provide to do during the recitations. I thought were great, because they were something relevant. You know, whether it's the way an avocado ripens, whether it's how the ocean is buffered. Like, how efficient would a solar car be versus like, you know, where you're getting electricity from burning fossil fuels versus if you're just burning them directly. Like, they're very relevant problems, so I thought it was cool like to see kids kind of go, "Whoa. Like, I guess I didn't realize that." […] And these problems were written in the sense that it was very easy to see the real life applications and to go, "Oh, this is why someone would want to study this. Maybe that person is not me, but I'm glad there are people that do."*

Leah valued the applicability of the in-class questions that the instructors provided. She also recognized that some of her students experienced moments of realization regarding the relevance of the course.

Megan's perspective on relevance in the course was less straight forward. When asked about the relevance of the course, she replied:

Some, yes. Other things, no. The thermochemistry, not so much. I think there was a section about electrochemistry that we had, not so much. I think some of the acid base chemistry, I think I will have to know that in further career stuff, but I'm not so sure. I guess certain parts that relate to the human body or medical things, yes, but the majority of class, probably not, I wouldn't think. But chemistry's everywhere, so I think it's the foundation of science.

Megan appeared as though she did not want to say that the course was relevant, but she continued to correct herself, ultimately claiming that "chemistry's everywhere," and that "it's the foundation of science."

Not all students, however, saw the course as relevant. When asked about the relevance of the course, Chelsii replied:

No. A basic background knowledge, yes. I don't think what I wanna do has to know the specific math reactions to everything. […] In Organic Chemistry I just remember doing all these acid-base reactions that were so complicated and then I got there and she was like, "Okay, I'm gonna erase everything that you know from your general chemistry acid-base knowledge because you probably have a bad experience with it and I'm going to tell you what actually happens in the reaction and show you why." Instead of

> *all these numbers that I don't understand. Maybe if I was going into Chemical Engineering or something, but in medicine you don't need to know.*

A respondent from the course evaluations shared a similar account, claiming, "I'm not a science major (though I am pre-med) and a lot of this material was entirely unrelated to my plan of study. I really don't think I learned anything from this course, and I only gained stress, which triggered my anxiety." Both Chelsii and this respondent did not see how this course would support them as they pursued their careers. Chelsii even went so far as to claim that the course that followed this course actually undid some of what they were supposed to have learned.

Chelsii also commented on the relevance of some specific content that she remembered from the course. She shared:

> *I remember one specific question.* […] *It was talking about "Ice melts at this rate and then we're gonna use it in a steel cube." Then it was like, "How is ice melting bad for the environment?" It's like, that sure might relate to someone who's thinking environmental science kind of stuff, but it's so basic that it doesn't benefit anyone in the room. So, we spent time talking about that instead of how to solve the problems. I was like, "It's bad for the environment 'cause the Arctic ice is melting and there's animals that live there."*

Even though she recognized the problem's application to environmental science, because it could not be directly applied to her major, Chelsii concluded that it was not relevant and was a waste of time.

Harold also commented on this question. He explained, "Like the ice melting or something along those lines. *[…]* Yeah, that was cool. It was relevant, but I think some of them were ... That's a stretch to be teaching that. But it's a problem. It showed up in the exam. It is what it is." He was not pleased with the question, but he recognized that it carried some application to the world outside of the classroom.

When asked if he believed the course was relevant for him, Harold replied, "No. *[…]* I suppose there would be an overlap if you were to say biomedical engineering. There would be a concentration spanning the two, but Gen Chem II, it was just one to check off." In Harold's mind, the only thing relevant about the course, was that it satisfied the requirements for his degree.

Susie, the TA, acknowledged her students' perception of the relevance of these topics. She recalled:

When we were doing thermodynamics and equilibrium I know they had a problem about an ice cube melting in tea, and my students actually thought that was really funny, because I always walk around with my iced tea in the mornings. […] They're always like, "Yeah, Susie's tea. We can figure out this sort of stuff. If the ice cubes melt, how much ice is remaining afterwards?" There were some problems that they could care less about. Sadly, more of the environmental ones. So if you were drinking tea on top of Mt Everest, they're like, "Well, this isn't practical," but it had to do with elevation change, and pressure change, and that sort of stuff. Some of the problems were relevant. Some of them still relevant, but not really.

Susie saw the efforts of the instructors to make the content relevant for the students. She saw that they succeeded in some cases, especially when it came to things that the students could see in the moment. However, she recognized that even though some topics were presented in a way that showed their applicability, they lacked practicality for some of the students.

The relevance of the course content was not realized by many of the students. They mostly saw the course as a checkpoint on their path to a degree. When they acknowledged how the course content could be applied, they also claimed that it was not a practical application for them. Overall, the students did not make connections between the concepts or skills that they learned from the course and their own lives.

6.1.3   Recognition of the Assessment Options

The code *assessment options* are defined as statements about tasks used to assign student grades (see Table 6.1 for definitions). This coded primarily focused on exams and quizzes. While the presentations also emerged from this code, they will be discussed in the section on platforms for competency.

In Dr. Steve's course evaluation respondents expressed frustrations with the way that the in-class quizzes were structured. These quizzes were on the lecture videos that students were supposed to watch before coming to class. These quizzes were tied to the students' participation grade, and depending on their performance, the quizzes could affect this grade as well. There appeared to be a sense of "double jeopardy" with regard to this structure. One respondent explained,

"the quiz failure/pass being connected to our participation was completely unnecessary. Even if I fully participated in class and was completely involved, it didn't matter because I had trouble passing the quizzes so my participation grade went down the drain."

Megan expanded on this idea, sharing:

> *With the five point quizzes, a lot of students depend on class participation for some sort of a cushion, and that was taken away if you did bad on the quizzes or didn't understand the material sometimes. I think it was if you failed two quizzes then your participation would be affected or something like that. […] I just think that if a student doesn't understand material, maybe four quizzes in a row we'll say, that doesn't mean they're not participating and actively learning and asking questions.*

Megan claimed that students could still be participating and learning during the rest of the session, even if they did poorly on a quiz.

Isabella shared that the videos were not helpful for her when it came to the quizzes. She explained, "If the people only rely on the videos, I don't think that they do good on the quizzes, because I didn't do good on the quizzes in the first weeks when I was only watching the videos, but when I started reading I started to do well." Since the quizzes were advertised as being on the material from the lecture videos, that was where Isabella tried to learn. However, her TA told her that she should focus on the book if she wanted to improve, and that is what she did.

One of the respondents from the course evaluation proposed, "the quizzes being at the end of recitation instead of the beginning so students have time to ask their questions and be able to work/talk about the new difficult concepts before just guessing on the quizzes."

This idea was also proposed by one of the TA participants. Leah suggested, "maybe if the quiz for the before ... Like, the did you watch the videos quiz could be online, and then maybe the last 10 minutes were gonna be some kind of quiz about were you present today and alive during recitation?"

Pete, on the other hand, felt that he learned from the in-class quizzes. He compared it to his experience in the traditional version of the course and thought that these were much better. He explained:

> *I actually felt I learned more from the quizzes, […] For a learning tool, I like the multiple choice better because the quizzes ... They allowed me to*

apply the knowledge that I learned, instead of just memorizing the concept questions. It sort of reinforced me, if I was able to get one of the answers that was offered. So, for me, multiple choice is like a reward-based thing. If I got it correct, or at least have something there ... I know I was on the right track at least, because I got an answer that was at least expected from ... I was doing something right, at least.

Pete enjoyed the opportunity to challenge his competency and appreciated the simplicity of their multiple choice nature.

As for the exams, the course evaluation provided recommendations that they should be "longer *[...]* That way each question will not hold so much weight on the final score of the exam," that "there is simply just not enough time to do *[the free-response]* and write down all of your work and do the work the way they want it to be done," and that they "would prefer more *[free-response]* problems because then even if the final answer is wrong, some points can still be earned." The student participants, however, seemed to focus on the free-response questions.

When she discussed the free-response questions, JoJo explained, "We're not used to it. We're used to MCQs now a days."

The TA, Susie, affirmed this perspective and shared that, "It was the first time that *[the students]* had done a free response portion on the exams, and students a lot of times were confused with what to expect for it."

During the focus group discussion, the student participants discussed their frustrations with the exams. Harold began, "the first exam, all three of my answers were correct for the short answer, and I got a seven out of fifteen. *[...]* I didn't show my work. This is the real world here, you get to the destination."

Chelsii agreed, "Yeah. What annoyed me, with those exams, is you'll show your work, writing down everything that you can possibly think of, so that you get all the points, but you only label it units, or whatever, at the end. *[...]* Or in one step in the middle, and the end, but if you didn't write it at the beginning, or you missed one spot that they were looking for, you got five points off."

In her interview, Ashley continued to express this frustration, describing how, "every single step, you have to put the units in the numerator, in the denominator, when you're multiplying, every single thing."

This was a particularly aggravating topic for Harold. He recalled:

So I was there. I was getting through [the exam questions] *as quick as I could, the answer was right. It was right, but I was trying to get to a destination. I wasn't worried that step two of this equation was missing something in the denominator. I was just trying to go for it. And that was very frustrating because on that first exam I did have all the answers right.*

He went on to share that on one exam his friend did not provide a final answer on some of his questions, and instead explained how he would solve the problem. Harold said:

I think he might have been missing maybe one answer, maybe missing one point, but very, very close to almost a perfect score, just for writing down equations […] just writing out how they would do it, if they had the time or whatever prevented them from doing it, if they had that. And that was a much higher grade than I had gotten. And that's extremely frustrating, being taught to get to a solution, and I got there.

Harold believed that "if the unit was right, and the answer was right, the work up top is irrelevant." The fact that he had the correct answer, but was marked down for not showing his work seemed unreasonable to him.

Susie, a TA, agreed with this belief. She explained:

When you're marked down for not writing out kilojoules or something. I think it's pointless to take points off. If you have it at the end, is what I care about. Yes, I care about units. I find them helpful myself. But I don't think that they should have points taken down for it. I think that when it's a 15 point problem, and you're taking off one point for a unit for each part, that's three points out of 15 that you're taking off for units. I don't think that that's fair to them, especially if they've demonstrated "I can do this problem. I can do this math. I understand what's going on, I just didn't write kilojoules." I'm with them on that.

A few student participants recognized a benefit of one aspect of the exams. Ashley explained, "All the solved in-class questions correlated perfectly with what was given on the exam in free response, so that was the thing that got me through the class."

Susie, a TA, also recognized that some of the exam questions were the same as the in-class questions. She shared, "A lot of times on their exam there were problems that were verbatim from recitation. There were a few that were altered, but a lot of times there were the exact same problems."

Harold expressed this recognition, as well, but maintained that he had difficulty getting full credit. He shared, "they were identical to the three written on the exam. But it was just so hard to get full credit. I was legitimately mad after my first exam because I had three right answers, but I got like a 7 out of 14 because I was missing units, didn't show my work, did something else."

Chelsii also recognized this. She remarked:

> *If you know how to do those problems you're gonna do pretty well on the short answer part of the exams. On the short answer parts they had a question and you had to write out the whole steps of the process to get to the answer.* […] *In each individual step that you take you were supposed to write the units. If you understand the units that you're supposed to get at the end, I don't see why. I've taken multiple classes that use units. Like physics and math we even have some problems, in previous chemistry classes and my biology classes. You just have to know the end unit, even if it's short answer.* […] *Based on feedback I got there was a lot of people that were rushing to finish. With my extended time I was still rushing to finish, and so you don't think to put the units. You're just trying to get to the answer in time.*

She recognized that the in-class questions were extremely useful when it came to the exam. However, like Harold, Chelsii did not like that the units had to be included in each step and felt that there was not enough time to complete it all the way that the instructors wanted it to be completed.

The overall perceptions of the assessments were best summarized by one of the course evaluation respondents who said, "This courses grading system feels like it's set in a way that you receive point deductions for every small mistake made. The course does not leave much room for error which is necessary when learning challenging material."

6.1.4 Perceptions of Video Lectures

The code o*nline resources* is defined as statements referring to materials on the internet that are required to complete the course or can be used to supplement learning (see Table 6.1 for definitions). While the course used multiple online resources, including online homework and an online textbook, the student participants seemed to focus primarily on the online lectures.

This topic received passionate critique or applause depending on the student. The course evaluations provided remarks ranging from, "The online lectures had nothing to do with the home

works and I spent most of my time teaching myself from the book," to "I think the lecture videos are very helpful for both recitation and the online homework. They were extremely helpful and had clear explanations and examples."

Harold's comments focused mostly on the quality of the videos. Although each student participant made a comment about the quality, Harold was by far the most focused on it. He could not seem to get passed this aspect. In the focus group discussion, he grumbled:

> *Because you looked at the date stamp on his lecture videos and like, "Great, I'm watching a video from 2015. I'm glad a lot of thought was put into the instruction." […] And it's never the right size. It's 2018, we have 4K videos on YouTube, on the phone. I could watch a 4K video, flying on a plane at 40,000 feet, but on a campus with basically one gigabyte download and upload speed, I'm looking at something that looks like it was produced in 1980, and I'm viewing it on a Nokia flip-phone.*

Harold was appalled with the quality and effort that he felt was put in to making the videos, even calling them "abysmal" during his interview. He also expressed his frustration with the fact that they were originally made in 2015. In his interview he continued to vent his opinions, saying:

> *The videos he had here were like. They were four minutes, five minutes, seven minutes. He was talking about Days of Our Lives at one point. This I think was Dr. Bradley's stuff. And that was, I don't want to say useless, but it kind of was for me. I like the lecture format. I'm paying to go to college. I've been so accustomed to drilled 50 minute lectures. […] And those also were, I think I mentioned, film back. The date stamp was like 2015 they were filmed. It's like, my tuition didn't go down because you filmed it two years ago.*

His prior experiences in traditional lectures, the general quality of the videos, the seemingly random asides, and the age of the videos were enough to cause Harold to take them less seriously in his engagement with the course. He explained:

> *I was probably at a 50% watch rate for the videos to be perfectly honest. Because I would start watching it, and it would be so blurry. I would just look at what he had printed out for it, and try to learn with just the handwritten slides. Not saying that the handwritten were any neater, but at least the handwritten were messy and clear in terms of blur, instead of looking at messy and blurry. And not to rip on him, but Professor Bradley*

would have a habit of working down the paper, running out of room because
he had PowerPoint slides, and then kind of working around the edges here.

Harold attributed his decreased watch rate to the quality of the videos.

The TA, Susie, also recognized these issues with the videos. She described, "With Dr. Bradley, sometimes he had lecture videos where his dogs were barking in the background. It's like, 'You couldn't have taken a little bit to re-record this, or cut that part out?' You recorded this video three years ago. You could possibly update it in the time you've taught this course." Susie agreed with Harold's perspective and was disappointed by this instructor's failure to demonstrate the effort he expected from the students.

Other students who were displeased with the videos expressed concerns regarding the content. In the focus group discussion, Chelsii shared, "To me, the lecture videos were not enough for me to actually learn the material." She continued in her interview:

> *I didn't understand what was going on in the videos, which made me confused whenever I went to recitation. There are some where it was too slow at some parts and then other parts were too fast of an explanation, if you even* [got] *an explanation. They weren't structured or formatted correctly when they would go through the stuff, so that it would make sense to me.*

Chelsii found that the videos were not enough, that they confused her more than helped her, and lacked the examples necessary to support her learning.

Several of the course evaluation respondents commented on this topic, too. They wrote, "I wish Dr. Steve would do more problems within the lecture videos that apply to what is on homework assignments and exams," and "Many times the videos did not correspond with the information asked on the quizzes."

Ashley confirmed this and said, "the recitations and the videos didn't match up."

Megan also shared in this concern. She acknowledged that she was able to learn from most of them, but sometimes there seemed to be a disconnect between the videos and the quizzes. She explained, "I mean, sure there's some things that he could have said in the lecture videos, but I think overall they were fine. I think they gave a good overview of what we were about to learn in class. But sometimes they wouldn't correlate with the quizzes, with the five point quizzes." If these

quizzes were supposed to be on the videos, she did not understand why they sometimes seemed to be about concepts that were only in the book.

Several students, however, expressed an appreciation for the videos. Pete explained:

> *I definitely preferred them because they tend to be shorter, and I could watch them when I was able to. Those little clips were ... They made me pay attention more, because I had to actively watch or pick a new clip, as opposed to just being in a lecture and then you zone out for the hour. You're like, "Oh, wait. What just happened?" So, they kept my attention more.*

Pete, along with JoJo, enjoyed that these were short clips on specific topics. JoJo shared, "I just feel that I really like the way that it was like little, 16 minutes, 14 minutes. I liked it because sometimes you don't have time and you just need to watch it really quickly and just do your homework or something like that. So I think that's really helpful."

Pete also described how the videos were easier to go back to when he needed to refresh his memory on a specific topic. He explained:

> *Each of them presented a similar topic, but they were each geared towards a specific set of information, typically. […] I could re-watch it and sort of ingrain it, I guess, better than I would've been able to in a live lecture. And they were short, which helped in the re-watching, because then if I wanted to go back when I was studying, I could just pick the topic, typically, and in my opinion, that's better than the 50 minute videos that are on ... What is it, BoilerCast or something. Where you have to skim through, and you're sort of trailing through the entire lecture trying to find a specific topic that you wanted. So, I think the shorter, little clips of it are better than a full-on lecture.*

Being able to go back to specific topics without searching a 50 minute lecture was a significant benefit for Pete.

Some students would use the lecture videos as a way to study for an exam. According to Max, that was when he usually watched the lecture videos. He remarked, "Yeah, but I didn't watch much, though. I just watched before test, watch everything before test."

Isabella actually stopped watching the videos after a certain point. She was under the impression that the book was more important. She explained:

I stopped watching the videos and started doing problems on the book more than watching them, because they were just ... Problems out of the book, I was just like, "Why would I watch it when I can do it myself?" Yeah, I think that they would have explained better that you have to read the book and then watch the videos, or only read the book and the problems there. I think that would be more helpful for others to understand that the videos are not everything. The videos are not making you understand more, it's just a complimenting thing.

Isabella realized that she was able to get more out of practicing problems than watching the videos. In fact, she expressed that the reason others did not do as well, may have been because it was not made clearer that the videos were intend to compliment the book.

In the course evaluations, some respondents expressed that the videos were "too long." One respondent shared, "I would recommend shortening the video lengths and just state the key points you are trying to get us to know. The videos seemed to overwhelm me as they added up to sometimes over an hour each week."

There were other respondents, however, that felt differently about the length. One respondent pointed out the benefit of the longer lectures when Dr. Steve started instructing, and said, "*[Dr. Steve]* had longer lecture videos and really explained concepts and the things he taught really helped while doing the homework." Another said, "The lecture videos are much more informative which I like. I like that concepts are gone over more so than with Dr. Bradley. *[…]* Although the videos are long they are worth it."

Chloe, the TA, commented that there appeared to be two perspectives on the videos. She explained, "With Dr. Bradley, *[the students]* liked that *[the videos]* were short and it just had what was required but they liked that there was the option at least for Dr. Steve to go on, see an example of a problem and I think Dr. Bradley did that every so often but not nearly as much as Dr. Steve did." She saw that some students liked the option to go deeper, but other students wanted to get to the point and move on. Chloe saw that there was simply no way to please everyone.

6.1.5 Recognition of the Usefulness of the Classroom Layout

The code *classroom layout* is defined as statements that comment on the classroom venues in relation to suitability, personal appreciation, influence on students' learning, etc. (see Table 6.1

for definitions). During the focus group discussion and interviews, students reflected on the classroom and commented on the ways it supported their learning.

Ashley loved the building. She explained, "I liked it a lot just 'cause I could be around people, so I felt more at ease. When I'm in a classroom with the desks in lines, I don't thrive. When I'm able to talk freely among people and figure things out, that's my ... Yeah."

Later in the interview she continued, "I really liked the fact that it was interactive, that we all got to talk to people. I think that was a good thing, was at WALC, the Active Learning Center." Ashley appreciated the way that the space promoted interaction with peers and she felt that this kind of environment was a place where she thrived.

The other student participants were not as taken with the space for a variety of reasons. Harold frequently mentioned that he "hated WALC," and described it as a "waste of space." When he commented on the classroom, specifically, the only gripe he had was with regard to the demonstrations. He explained, "None of the fun experiments were able to be done in that classroom in WALC. They were like blowing up hydrogen balloons, doing a lot of fun stuff with fire that all seemed to be prepared in Wetherill 200, the traditional classroom, that were not able to be carried out in WALC."

The rest of the student participants, however, were more concerned with the room's influence on their ability to learn and access the instructors. Megan recalled, "My table was in the middle of all the tables, and so it was hard to get *[the instructor's]* attention *[…]* I think, the tables on the end had more access to him."

Isabella's problem was magnified by the fact that her section met when there were two separate rooms that the instructors had to move between to conduct the course. She explained, "They have two classes. Two big classes, I understand why they are not coming around because everyone had questions and I'm in another class with having questions, too." She also shared that she was in the room with less students and said, "I understand why the professor wasn't very invested in my class, we were a few people in comparison to the other class. *[…]* I didn't have a lot of communication with him since I think he focused more on the other class than in my class." Because Isabella was in a session that met between two rooms and she was in the smaller room, she felt that she had less access to the instructors.

Susie, who was a TA in the smaller room, also noticed that the space seemed to have an effect on her students. She mentioned:

It was also weird with my Friday afternoon section. We were in two different rooms because we had too many students for one room. A lot of times I preferred to be in the little room, because my students were like, "Yeah, we like the little room," which then I found out later some of them didn't like the little room because they're like, "Why are we always in the smaller room?" But with that, the smaller room always seemed to get done before the larger room too. Sometimes we would actually have students present, and then start on the next problem. Whereas the other room wouldn't start on it until ten minutes later, and then the smaller room would sometimes get out early. There was a lot of sitting around with that section, but we tried to minimize it.

Susie identified negative and positive aspects to being in the smaller space. They were able to move faster, but there were also more opportunities for the students to lose interest.

Chelsii's grievance regarding the room had to do more with the way they were spaced in relation to where presentations would be made. She described:

I was always at the back tables and I never heard what was going on when someone was presenting. Some people's handwriting's not as legible as others, so it just makes it more difficult. If someone writes smaller and then they back and away and they're like, "Oh, you can't read that if you're five feet away from it."

Chelsii was irritated that she was unable to hear what presenters were saying or read what they wrote on the whiteboard. She felt that this stunted her ability to learn in the space they were in.

The physical space where the students met for the formal class sessions, influenced students' perceptions of the course and their ability to perform well in it. The classroom was suited for collaborative activities, but for some students it made it tougher for them to access the help they needed.

6.1.6   Improvement Suggestions

The code *improvement suggestions* is defined as statements that make suggestions or express desires for how the course could have been designed or conducted differently (see Table 6.1 for definitions). Students made recommendations for the improvement of the lecture videos, time available, certain instructor and TA interactions, quizzes, and explanations. These topics, however, emerged in other themes as well, and will be primarily presented there.

One of the improvement suggestions had to do with opportunities for in-person lectures, rather than, or in addition to, the online lecture videos. During the focus group discussion, Harold described his experience with a calculus course that was similar to this course. However, he pointed out some areas that the chemistry version could have implemented. He described:

> *The entire first half* [of the calculus course]*, was the professor summarizing the entire lecture. The entire three lectures that you were supposed to watch for that week. So, he'd go over, basically, the tricky points, the hot topics, of every single one of those lectures, do a problem or two, explain all of that, any questions go through it, and then do the problems for the second half.*

Ashley replied, "I think that would have been perfect."

As the focus group discussion progressed, other participants built upon this idea. Ashley added:

> *Make one hour, since it's two hours long, you need to make one hour talking about, a little bit about the lecture material, and then going over that for maybe a half an hour. And then another half an hour, going over questions that students had about that, because people are going to have questions. They can't always just go to office hours, you know? […] and then the next hour could be doing problems, I think. Cause it's two hours long, there is so much more you could be doing than three really, really, really hard problems.*

Chelsii even went on to suggest that they "have an optional lecture, or an optional session where they actually explain the problems, if you didn't understand it."

During her interview, Ashley reiterated almost exactly what she said in the focus group discussion. She even went so far as to add, "I would've been fine with coming in for chem six hours a week, or seven, I guess, cause three hours lab, two hours of recitation, and two hours of lecture. I would've been fine with that. It would've been a lot of work, but I probably would've gotten an A."

Some students also suggested increasing the number of TAs who could help answer questions during the sessions. Harold described that this was one of the advantages to his flipped calculus class. He explained, "they had a higher TA to student ratio."

Isabella even suggested, "You should try with undergrads. I know my friend is a TA for math."

The in class quizzes were another area identified by the students for improvement. In Dr. Steve's course evaluation, a couple of the respondents recommended that the quizzes be placed at the end of the recitation sessions. One respondent shared, "Having the quiz before class was a bit weird for me since we would be going over that material that same class period. I think it might help if the quiz was at the end once we have fully grasped the concepts."

The student participants also shared similar suggestions. Isabella explained that instead of having the quizzes at the beginning they should have them, "maybe at the end of the class. Or if they teach something week one, in the week two they quiz on what you learned in week one."

Leah, the TA, also provided a comparable suggestion for the quizzes. She offered, "maybe if the quiz for the before ... Like, the 'did you watch the videos' quiz could be online, and then maybe the last 10 minutes are gonna be some kind of quiz about were paying ... Were you present today and alive during recitation? I don't know if that's a better way."

Students also felt like they were missing a sense of resolution on some of the concepts that were supposed to be covered in the course. Chelsii proposed, "If I was the TA, and I know they couldn't, I would have gone on that one big board, and taught it to the group of the four tables how to exactly solve the problem and why to do it."

Megan corroborated this explaining, "I feel like it would be more beneficial if they spent the time, instead of students going to go present, having the lecturer explain what we did."

The TA participants recognized this as a problem as well and provided their own suggestions to improve this. Leah observed, "I think there's gotta be some way of wrapping things up better for them. But I don't feel like we always reached a point where everyone felt comfortable. And again, like for the first problem of the day, always. I feel like I was always able to tie up the loose ends. But towards the end of class, you just run out of time."

Susie recognized that the instructors would try to provide this "closure" on occasion, but it did not seem to be enough. She explained, "I wish there was just some kind of group closure with the problem too. Maybe once everyone finished presenting, if Dr. Steve or Dr. Bradley would make a few comments on it. Sometimes they would, if it was a really tricky problem. I know Dr. Steve was pretty good with that. But a lot of times that felt like it was like okay, we presented. What for? I feel like the students felt that too."

The suggestions students and TAs provided to improve the course were centered around features that would better support the students' learning. They felt that there were pieces missing from the course, such as in-person lectures and closure on concepts from the problems that they worked out during the sessions. Students believed that by implementing these suggestions, the course could be improved.

6.1.7   Summary

The students' perceptions of the way the course was designed to work, influenced their experience with the course. They faced frustration when they noticed that their TAs were unable to prepare for the course, and felt burdened by the assessments and the grading system. Student perceptions were mixed when it came to the lecture videos with multiple contradicting claims and requests for improvements. They recognized different ways that their meeting space encouraged collaborative work, yet hindered their ability to access help in different ways. The course content was rarely seen as applicable, and when it was, the students claimed that it lacked practicality. The different experiences that students had with the course design left them with suggestions that they believed would help to better support learning in future iterations.

6.2   Perceptions of Different Events in the Course

The codes that highlight a student's perception of the way the course was executed are outlined in Table 6.2. The overarching theme *Course Actions* refers to any statements that highlight specific events that occurred as the course was executed. This theme is further delineated between different perceptions of course events and the ways that these events were experienced. The events, as well as the way they were experienced emerged as influences to student perceptions of the course.

6.2.1   Perceptions of Chemical Demonstrations

The code *demos* is defined as statements that describe in class productions that illustrate aspects of chemistry and/or their purposes (see Table 6.2 for definitions). Students referred to these productions as demos, demonstrations, and experiments. These demonstrations were used to illustrate applications of concepts from the chemistry course.

As one would expect, the "flashy" nature of these productions were something that the students generally enjoyed and looked forward to. The TAs even recognized this. Chloe, the TA, explained, "all of my students loved those *[demos].*"

Table 6.2. Course Actions Codes. This table provides an overview of the different codes under the course actions theme. *Italicized* definitions were not used for coding, but were parent categories of applied codes.

Theme/Code	Student and TA Codebook Definitions
Course Actions:	*Statements that identify events in the course*
• Demos:	Statements that describe in class productions that illustrate aspects of chemistry and/or their purposes
• Time Management:	Statements about time required for the course and time spent on components of the course
• Study Techniques:	Statements about course related activities outside of the contact periods and statements about how a student studied
• Platform for Competency:	Statements describing opportunities that allow students to demonstrate "understanding." (i.e., presentations, etc.)
• Investment/Return:	Statements that highlight the relationship between student expectations and effort
• Task versus Learning:	Statements that indicate a focus on completing a task rather than learning concepts/science/materials/etc. (Performance vs. mastery)
• Time of Class:	Statements identifying the time that the class was held.

Ashley reflected on the demonstrations, saying, "I mean, they were cute. I mean, I really liked them. I looked forward to them at the end of the class." She went on to add, "I looked forward to the demos, cause there'd be the quiz, then at least two or three questions that I'd have to struggle through, and then I could watch Professor Bradley do something ridiculous." Ashley enjoyed the seemingly theatrical nature of the demonstrations and looked forward to ending her time in class with them.

Isabella shared this appreciation. She explained, "All the experiments made me very interested about what *[the instructor]* was saying, but I don't know if that would be enough for me

to like what I was doing outside of class." While she enjoyed the in class experiments, Isabella did not think that they provided enough excitement for her to sustain her interest outside of the class.

JoJo also looked forward to the demonstrations and even thought about how exciting it would be if she could do them. She recalled:

> *I was always looking forward to* [Dr. Bradley's] *experiments. 'Hey he's going to do it finally.' So, that was cool.* […] *when it came to experiments and stuff. It made me feel like, 'Hey what if I become a chemist?' Or I don't know. Something like that. I think that would be so fun, doing all the experiments. And it just made me feel like, you know when we are kids we look at magicians and stuff. It just felt like that. It was funny. It was really fascinating honestly.*

The experiments were magical to JoJo and even prompted her to briefly consider becoming a chemist herself. However, JoJo did not think that they were relevant to the course content. She explained, "*[the demos]* were like not so related honestly. But they were just fun to understand. But apart from that they weren't super related." Even though she enjoyed them, JoJo admitted that they did not seem related to the content.

Megan, however, provided an explanation as to why she found the demonstrations useful and relevant. She described:

> *He would explain why he was doing the demo before he even did the demo. I mean, some people may think, "Oh, it's a waste of time. We don't want to see a demo," but I thought they were interesting. And he showed us physically what it would look like, the reactions that we were learning. I don't think they were a waste at all.*

Later in her interview, however, Megan explained that the demonstrations would sometimes get in the way of their learning. She recounted:

> *There was one thing that with the demonstrations, I would suggest leaving more time at the end for them because they would ... What would happen is we wouldn't have enough time to finish the problems that we're doing in class and they'd be like, "Okay, we have to stop because we have to do this demonstration." In that sense, the problem that we were doing is probably a little bit more important than demonstration, so maybe fixing that a little bit.*

Megan felt that they had placed more importance on the presentations at the expense of making sure that the students understood the material from the day's session.

Chelsii expressed the same irritation with the demonstrations and went so far to say that they were a waste of time. She explained, "We would rush through *[the problem]*, 'Oh, check the solution online for this one.' *[…]* so that was our explanation of how to do the problems so we had time to do a demo. *[…]* I didn't see why we were wasting the minimal time we had."

Harold, who had enjoyed the experiments from the preceding course (general chemistry I), was upset that they were unable to perform some of them in the room that they were in. He complained, "None of the fun experiments were able to be done in that classroom in WALC *[the active learning building]*. They were like blowing up hydrogen balloons, doing a lot of fun stuff with fire that all seemed to be prepared in Wetherill 200, the traditional classroom, that were not able to be carried out in WALC." Harold had expectations to see flashy experiments done live in this course, but was upset that many of them were done by video instead.

The chemical demonstrations provided moments of excitement and interest for the students. Some students, however, found that the instructors' priorities for ensuring that these demonstrations were performed, would sometimes detract from their learning of the material.

6.2.2 Recognition of How Much Time was Required for the Course and How Time was Managed

The code *time management* is defined as statements about time required for the course and time spent on components of the course (see Table 6.2 for definitions). Students had an acute awareness of the time they spent on activities related to the course. While time spent studying emerged from this code, it is not explored here. Instead it is presented in the section on study techniques.

When it came to time spent on the course, students seemed to focus on the time spent in recitation and the time spent to complete the in-class problems. Some students felt that the time provided to work on the questions in class was sufficient. One of the respondents to Dr. Steve's course evaluation shared that Dr. Steve gave "a lot of time to work through problems in class."

Pete appreciated the time that the recitation provided to ask questions of the instructors. When discussing the online lectures, he explained, "It didn't matter if they were online because we had two hours with *[the instructors]* every week. It was something that you wouldn't have been

able to get unless you went to office hours with a professor normally. So, I think that was a big thing." Pete valued the opportunities he had in class to ask the professors questions and get clarification on problems.

Other students did not feel as though they had the time to get this clarification that Pete mentioned. In the course evaluation, one respondent shared, "It would have been more helpful if we didn't have to do *[the presentations]* but instead *[the instructor]* left time open for questions. I never had time to ask questions because we would be pushed on time to get to the next in class problem." This student wanted to get clarification from the instructors during the course, but felt that there was never time since they were always pushed to move on to the next problem.

Chelsii also made this observation and claimed, "It was a two hour class and you did two problems the whole time and, my group every single time, never actually got a solution to any questions." Chelsii was frustrated, because even after all of the work that her group did, they would still run out of time to understand what it was that they did.

Megan alleged during the focus group, that her group never finished because the instructors were focused on doing the demonstration. She explained, "We literally ran out of time, every time, and then they'd be like, 'Oh crap, we need time for the demonstration, so we'll stop.'"

She expanded on this in her interview, informing:

> *I would suggest leaving more time at the end for* [the demos] *because they would ... What would happen is we wouldn't have enough time to finish the problems that we're doing in class and they'd be like, "Okay, we have to stop because we have to do this demonstration." In that sense, the problem that we were doing is probably a little bit more important than a demonstration*

Megan was frustrated that the demonstrations appeared to take priority over understanding the problems.

Max shared his experience with having extra time during the recitation. He described, "Half of us just figure out the question within five minutes, the other part of our group, the fast people, explain to the slow people. *[...]* sometimes when the question is easy, my group just figured it out within five minutes, and then we were waiting there doing nothing." Max's experience was that there was too much time available during the recitation and went on to explain that they should have provided extra problems to do in these cases.

149

Max also remarked, "I actually had a good time with it, and I like a whole online class instead of a traditional class. So, a flipped class, I think it's good because it saved my time, and I don't have to go to classroom every time." Max appreciated that he was able to save time by only meeting once a week in this course.

The TAs noticed that there was an inconsistency for how long groups would take on the questions. According to Ashley, this may have been a result of different groups on different days of the week. She explained, "My Tuesday morning students were ... They usually took a long time with the problems, and working through it. But it seemed like my Friday section always flew through it. Now I don't know whether that was because me as a TA having experienced this problem before, had I learned from it."

Chloe also shared, "It wasn't one or the other. It was literally either they had too much time or they didn't have enough time."

Leah considered how they could alleviate this problem, but concluded:

> *I'm not sure that there's really a good way to decide how much time you should spend on a problem. Like, I don't know. 'Cause I don't like watching people sit there and do nothing while they wait for the other groups to finish. It's like ... But you don't want to start them on the next problem 'cause then they're done even earlier with the next problem while the other group is just getting started.*

The TAs appear to be aware of this issue with the students, but ultimately, neither had a way to solve it for both extremes. Some students felt as though there was not enough time to complete their work, while others believed they had too much time, and TAs witnessed both of these extremes.

6.2.3   Study Techniques and Course Activities Outside of the Recitations

The code *study techniques* is defined as statements about course related activities outside of the contact periods and statements about how a student studied (see Table 6.2 for definitions). Students generally used the lecture videos to study, however, some students used problems from the textbook or their notes as additional resources for studying.

While Pete felt as though he learned more during the recitations, he still used the lecture videos to study. He said, "I liked the way the video lectures were set up because each of them

presented a similar topic, but they were each geared towards a specific set of information, *[…]* they were short, which helped in the re-watching, because then if I wanted to go back when I was studying, I could just pick the topic."

Pete claimed to only do this on occasion though. He explained, "I didn't tend to look things up in the textbook or online from the videos, unless I really didn't understand it, which didn't tend to happen too often *[…]* It was more like, I would watch them, and take notes, and I would re-watch something if I needed a little more clarification." Even though Pete used the lecture videos, they were more of a supplemental support than a primary source of instruction.

Isabella used the videos to study in a slightly different way. She explained that when the instructor was doing a problem in the video, she would "just pause the video and do it myself." This helped her to practice with the material before seeing how to do it. She would then correct herself and know how to do it the next time.

JoJo used the lecture videos to study right before exams and supplemented them with another online resource, *Kahn Academy*. She shared, "I used to watch *[the videos]* a week before the exams. *[…]* I used to go crazy three days before my exams. So I used to study a lot. *[…]* I used to actually study from Kahn Academy more than like, Kahn Academy online more than the videos because that would be more helpful for me."

Megan would use the videos to study in yet another way. She described:

> *A normal video, I think, would be between five and 10 minutes. I would take notes of them for probably 30, because I'd pause, write down, try to understand what I just wrote down, and then continue. Maybe rewind a little bit because I didn't understand something. I would use those lectures a lot and I would go over them even before an exam, reread my notes, go over my lectures if I didn't understand my notes, and then study them for the quiz we were going to have that next week.*

Megan would dedicate time to work through the videos, rewind it when she did not understand something, and try to understand it through her notes. She would return to these to prepare before exams as well.

Some of the students either stopped using the videos or never used them to begin with. Max explained, "I'm not heavily relying on the lecture. Like I say before, I will read the book by

myself." Max was never an avid viewer of the lecture videos. From early in the course he decided that he would focus on the book.

Isabella had this realization later in the semester and shared, "I stopped watching the videos and started doing problems on the book more than watching them, *[…]* I was just like, 'Why would I watch it when I can do it myself?'" She realized that she got more out of just practicing problems on her own, so she stopped watching the videos and switched to a technique that best supported her.

JoJo mentioned that she used practice exams to study. She described, "I used to do the practice exams and I remember whenever I used to go to the class, sorry exam, and do the real exam it was just really hard and was a lot different than the practice exam." JoJo found that the practice exams did not help her. She found that their content was not as rigorous as the actual exams.

The TA participants identified specific study skills of students in their sections who performed well. John shared, "The students that were really on top of it, they read the book. There's, of course, not everyone, but there's people who read the book, listened to all the video lectures, did the homework, you know, killed it, for lack of a better word."

Susie identified similar characteristics, saying, "They were the type of students that took learning into their own hands. They were the type that would work through practice problems, and come in with questions and that sort of stuff, and watch the videos ahead of time and take detailed notes on it." Susie and John observed that students who did well, were the ones who read the book, did practice problems, and came to recitation prepared with questions from the videos.

TAs and students identified varying resources and techniques that were used for studying. As the course progressed some students recognized that certain methods and materials were more or less useful than others, and chose to modified their study habits accordingly. Despite what students claimed worked the best, the TAs observed that a combination of reading the book, watching the videos, working through practice problems, and coming to class with questions were hallmarks of the students who tended to perform better than others.

6.2.4   Perceptions of the Presentations

The code *platform for competency* is defined as statements describing opportunities that allow students to demonstrate their understanding (see Table 6.2 for definitions). This code

152

primarily focused on the in-class presentations. While some aspects of the exams, quizzes, and homework also emerged from this code, they were examined in the section above on assessment options.

There were only a couple student participants who enjoyed the presentations. Pete reflected on his experiences with the presentations, sharing, "We would joke and stuff during the presentation ... They weren't too formal of a presentation, *[...]* I think, at least for all the groups that I experienced, it wasn't an added stress because ... Being in the groups just added a relaxed ... We were relaxed around each other, so that was able to take away from the stress."

While Pete's account focused on the atmosphere that surrounded the presentations, Ashley provided an account of her excitement to present. She explained:

> *I wish I'd gotten chosen more in the recitations because I only got one chance to go up, and when I did, I killed it. I did the entire problem, didn't look away from the board, explained the entire thing, and I was like, "Oh my God. I feel so cool." And one of my friends took a video of me doing it, and I sent it to my mom, and I was like, "I'm smart!" And she's like, "No way!" But I honestly wish I'd ... 'Cause there was this one guy that got called on like five times. I mean, I don't wanna be him, but I wish I'd gotten to do it two or three times. I think I would've been more encouraged.*

Ashley embraced the opportunity to show that she knew what she was doing and was spurred on by the experience she had to demonstrate her knowledge. She did, however, acknowledge that there were others who did not feel the same as she did.

Ashley went on to tell a story about one of the girls in her section who had "bad anxiety." She shared:

> *I like* [the presentations] *because I like going in front of people, but one of my friends, she could not walk up there because she has really bad anxiety. So, she got a zero. Everybody was really upset. So, she got a zero, and so did her group, just 'cause she couldn't go up there. And she was like, "I can't." She was stuttering, and it was a huge thing. So, I was just like it's not fair to people who can't do that. I was excited. I wanted to be called on, but I felt for her. It was hard, and I could see that happening in other groups too. […] People brought up* [getting an accommodation]*, and she was just like, "I'm not a baby. This is a two-minute lecture, a two-minute presentation I have to give. I just can't do it, and I don't wanna have to go out of my way to get excused from it."*

Even though she enjoyed giving presentations and wished for more opportunities to do so, Ashley admitted that this was not a skill that everyone was as eager to use.

John, the TA, mentioned that they tried to take these students into account. He shared that, they, "made accommodations for those people who did have some sort of doctor's note of anxiety." However, this only helped those who were willing to go through getting a doctor's note and work with the Disability Resource Center to get the accommodation.

During the focus group discussion, Chelsii recounted an experience similar to Ashley's. She explained, "Honestly, there was someone, in my lab section, that had social anxiety. So, whenever she got called up to present, it was not good. *[...]* You shouldn't be forced into that situation."

Megan, also, shared that "there were a lot of, I wouldn't necessarily say socially awkward, but just shy people in the group who didn't want to present. They'd forget everything, get super nervous, and just couldn't present effectively or teach effectively."

TAs noticed this in some of their students as well. Susie, the TA, provided an account of a student presentation where the presenter cried. She described:

> *I feel bad for some students that got called on to present that weren't comfortable presenting. I actually had a student cry on me once when she was called to present. I tried to make sure that they were all prepared before going up there. I always tried to ask if they were comfortable going up there. I told them they wouldn't be too harshly punished, as long as they had the scientific factual stuff there. They can struggle with it. I don't care how they deliver it. Just try your best.*

Chloe, another TA, contemplated whether there was a way that they could have identified these students ahead of time and removed them from the pool. She explained,

> *You don't know, which ones are the ones that are like actually have a phobia of speaking in front of ... I almost had a student cry like actually cry, […] It's stressful for me and it's stressful for the students, […] but I didn't know who those people were. So, I couldn't take out their names at the beginning of the semester to avoid the, "Oh my god, is she about to cry? Is he about to cry? Oh my god. I'm a horrible person. I'm kicking a puppy." That's literally what it was like. It was just terrifying.*

As daunting as it appeared to the students, Chloe was also anxious about the effect she was having on them as the TA.

JoJo indicated that, despite her extroverted personality, she was scared to present in front of her peers. She disclosed, "I'd be like super scared to mess something up on the board because there'd be like 12 people staring at me while I'm presenting it. I don't have any stage fright or anything. *[…]* I'm truly extroverted. I just feel that it was a lot of pressure to just do it on the board and not mess it up."

Leah, the TA, saw that students were nervous about their presentations and suggested a way that she thought could help to relieve their anxieties. She shared, "

> *You draw the name and they have to go. They don't have any time to actually reflect on what they did. Or maybe they do have 10 minutes to reflect on what they did 'cause they're sitting and they're doing this* [participant twiddles thumbs] *waiting for the next problem. But that's not what they're naturally gonna do because they don't expect to have to present.* […] *But, you know, if you said, 'Okay, you know, Lilly, in three minutes you're gonna have to present. Make sure you understand what's going on.' I think that would be far more effective, because then Lilly can ask everyone in her group all the questions that she has and be able to explain them when someone else asks her what those things are and not feel like she's gonna be put on the spot.*

Isabella provided her firsthand experience with getting nervous while presenting. She also provided several reasons why the presentations evoked these feelings in her. She described, "I was chosen four weeks in a row, and I know people that weren't chosen at all, and I'm not very ... I know what I'm doing, it's very hard to me to explain this to someone, *[…]* and I get so nervous."

She went on to explain:

> *The pressure I felt was more like they thought ... If you explain it to people that don't understand, they would understand. So the pressure of they have to understand from what you're explaining, that was my pressure. Like, what if they're not understanding it and it's my fault and they didn't understand this topic? After that, they didn't explain it again, or the professor didn't do it again. To compliment what I didn't say or anything. So that was my pressure. What if they don't understand and they do badly because of this? I was just feeling bad.*

Isabella's concern was not about being embarrassed, but about failing her classmates. She felt the pressure to make sure it was correct, so that her peers were able to succeed on their exams and assignments.

This pressure Isabella felt, combined with the pressure to get the points for her group caused her to make mistakes. She claimed:

> *The participation grade that if I do bad, they* [her group members] *do bad, and I'm like ... That was the pressure, and that would affect ... I would get more nervous and that would affect what I was saying. Maybe sometimes I was speaking Spanish, I know that. Sometimes I confuse English and Spanish, and then the TA will look at me like, "What?" I'm like ... Then I have to resay it and stuff like that.*

Isabella did not believe that she was incapable, but the *punishment* for not doing well on the presentations appeared so disastrous to her, that she would get nervous and fumble during her presentations.

The concern about learning the material came up from other student participants as well. During the focus group discussion, Megan began, "For me, I think the majority of the problems, or all of the problems, could have been solved if students just didn't present."

"That wasted a lot of time," agreed Ashley.

Megan continued, "I understand working through problems in groups, but I don't think ... I think the teachers should teach the recitation as more of a lecture, and then there shouldn't be any presentations. Like, it shouldn't be on the students shoulders, to make sure all the people in their group understand this problem."

Some of the students had the impression that the learning occurred through the presentations. They felt that this burden should not be placed on the students. In her interview, Chelsii added to this idea, explaining, "There's just so many things that it is very hard for a student to be able to understand the ways to teach so that others would learn from it."

When it came to TAs providing feedback on presentations, Megan shared:

> *If I went up and presented something that I just wrote, or that my group just did, my TA wouldn't really say anything. He would be like, "Yeah, that's fine." And then I'd just sit back down. So I wouldn't know, "Oh, I did this really well, or I really did this right, or there's something I could have improved on, or units, or anything like that."*

She never experienced the closure of knowing that what she presented, or what others presented, was correct.

Several TA participants claimed that they tried to make sure that they asked questions or provided some kind of closure for their students. John, the TA, shared:

> *One thing I was big on, as a TA was, I would ask a lot of questions after they finished presenting. Everyone claps and everything, and I would ask, does anyone have any questions. Maybe some, one or two people would have questions. And I would try and ask a few. I would try, if there was time, I would try and just probe their knowledge a little bit more. Maybe come up with some hypothetical scenario for them to deal with.*

Another TA, Susie, however, had a different experience. She explained:

> *I feel like I was unable to provide closure, depending on if other people were still presenting. Sometimes my students would take a long time to present, and I could tell the other tables were ready to go. Then I don't have time to make a closing statement. What I would usually do was try to reiterate sometimes their main points, so they would go up and write on the board, and I would just recap. "Okay, this is how we did this." Sometimes I would ask if there were questions, depending on if there were time. Usually, they had enough opportunity to ask questions if they were confused with me bouncing around between groups. I really feel like I wasn't able to provide closure for them though.*

Susie wanted to make sure that the students felt as though they understood by the end, but many times they were unable to do that because the class needed to keep moving.

Later in his interview, John acknowledged that sometimes the presentations were stunted because of time. He admitted, "At the very least we tried to get through, wait until all four presenters were done, but usually when three were done, and there's one, like that's halfway done, we had to kind of wrap things up a little early sometimes."

Chelsii expressed her concerns about the space in which the presentations were made. She explained:

> *Whenever we presented it to the whole group of four tables, there's four different people that are presenting at the same time. After every time that someone finished presenting, everyone clapped. So, you couldn't hear.* […]

> *I was always at the back tables and I never heard what was going on when someone was presenting. Some people's handwriting's not as legible as others, so it just makes it more difficult. If someone writes smaller and then they back and away and they're like, "Oh, you can't read that if you're five feet away from it."*

The space in which the presentations were given, made it difficult for them to actually be productive according to Chelsii. Given the noise, the spacing, and even individuals' handwritings, she felt that it was more difficult to learn the material.

When it came to the presentations themselves, Harold and Chelsii provided accounts of how their peers helped them during their presentations. Harold's was rather simple, where he described:

> *I presented once officially, and then I presented once to prove the professor wrong. The time I presented officially, my name got pulled out of the hat. I probably didn't even know how to do the problem. My team turned around, held the board up. I copied what was off the board, knew the general gist of what was going on, talked my way through it. Everybody clapped, and I went back to my seat. It went fine.*

Chelsii gave a similar account, sharing:

> *Whenever I'm like going up to present, I've had like the table that was like close to the board would always help me because my table's too far away to even contribute to the conversation. And so, the table like knew. I was like, "Hey, I need some help." And so they would help me. I don't know how much of like the TA was supposed to allow or like actually noticed, but it didn't bother me.*

Both Chelsii and Harold received help from others in the class while they gave their presentations. Other students were under the impression that this kind of help was not allowed.

The points that students received as a result of their presentations served as part of their participation points for the course. Depending on how a student from their group presented, they would get a certain amount of points as a group. Many students did not like this, and made claims that it contributed to the stress that they experienced. Isabella explained:

> *If you presented well you had good points, if you presented badly you didn't get a lot of good points. The one that bothered me was like there were some groups that never presented, or because they changed a lot. There were some people that never presented, it was like, "My participation points weren't affected at all." I'm like, "Mine, yeah." And I felt bad, because I affected my group, too.*

She was frustrated that there were some people who changed groups in a way that prevented their grade from being affected by the presentations, because the groups they were in never presented. She also felt bad, because her presentations affected her group.

Isabella also claimed that when someone lost points for their presentation, it seemed to make engaging with the group pointless. She claimed:

> *If you participated and you know the stuff, but you go there and you're like, "Well, I don't know how to teach it." […] And they took points off for that, I'm like, "Well, what is the point that I actually engage in my group?" But did bad here, rather than if I were sitting back, not being called, and get all my participation points for not doing nothing.*

Isabella felt that she, and her group, were penalized for being chosen to present, rather than earning points for demonstrating competence.

Susie, the TA, acknowledged that her students who were doing well in the course, may have felt this way, too. She explained, "I feel like the students that were really good felt like they were being punished if they had someone that didn't do so great."

Another TA, Leah, outright admitted to not liking the presentation and recommended that the instructors get rid of them. She shared:

> *I think that it's a way to make students really hate having to come to class. […] I did not like the presentations. Just 'cause I don't like making my students uncomfortable, quite frankly. Like, I want them to enjoy learning and I want them to like coming to class. And I don't want them to be afraid that they're gonna have to present on something that they don't know because I wouldn't want to do that either. So I didn't like that. I would do away with those.*

Leah, not only empathized with her students, she recognized the demotivating influence that the presentations had and called for their complete removal.

159

The students had numerous perceptions of the presentations, which influenced their perceptions of the course. Most students found them to be stressful, as a result of the points that they were trying to earn or the information that they were trying to convey to their peers. The TAs also recognized this anxiety in their students and some even believed that they should be removed from the course entirely. The presentations served as a source of much of the students' hostility towards the course overall.

6.2.5 Perceptions of Students' Expectations in Relation to Their Efforts

The code *investment/return* is defined as statements that highlight the relationship between student expectations and effort (see Table 6.2 for definitions). Students felt that the effort they put in should have provided specific results.

In the course evaluation some respondents claimed, "I felt that no matter how hard I tried I just was not getting the material." Even attending SI sessions and getting a tutor did not seem to help according to one respondent who asserted, "I have a chem tutor and go to SI sessions and am still doing poorly in this course. I have always liked chem until I came to this course."

These comments were affirmed during the focus group discussion, where Megan began, "I spent a lot of money for a tutor, and it didn't even help. The tutor did not help. *[…]* Tutor, and SI sessions weren't enough, and doing chem everyday was not enough."

With this statement, Chelsii rhetorically posed, "If that's not enough, honestly, what would be?"

Megan returned to this frustration during her interview, where she vented:

> *It just bothers me really badly that I've never tried as hard in a class as I've tried for this* [class]. *I can say that with absolute certainty because I got a tutor, I went to every SI session, I got outside help of the SI sessions, and I did over … I did Chem every day to try to get my grade where I wanted it to be and it just didn't do anything. I think it was the fact of just feeling like, "Wow, I still got a D even though I tried as hard as I possibly could."*

Megan left the course without understanding how she could have improved. She did everything that she could think of to get a good grade, but none of it worked.

Ashley shared a similar report in her interview. She explained that when it came to chemistry courses in the past, she could never get anything more than a C, and despite her efforts,

it continued to hold true for this course. She described, "In chem for me, it's always been a C. Like, I can't go above that. I can't- … I can probably go below, but, I mean, if I try my hardest, the best I can do is a C. And that's been a trend since like sixth grade. *[…]* I got what I thought I'd get." Ashley felt stuck and that her effort did not make a difference. She explained that no matter what, she had expected to get a C.

As a senior Harold expected that this course would be less effort than most given that it was a 100 level course. He was frustrated to find that he was missing points for details he believed were unimportant. He explained, "it was just so hard to get full credit. I was legitimately mad after my first exam because I had three right answers, but I got like a 7 out of 14 because I was missing units, didn't show my work, did something else. *[…]* Coming from engineering where you're crunched for time, you get the right answer, good." He believed that, "if the unit was right, and the answer was right, the work up top is irrelevant." He felt that he had put in the sufficient effort but was not getting the scores he expected.

The student participants knew that some effort was required in order to do well in the class. Max explained that the more effort a student puts in, the better they should do. He stated, "I think if someone wanted to learn on the class, have to read the book and do all the practice questions."

JoJo took Max's idea a step further, explaining, "I just feel every course can be studied well if you put in the effort. I did not put in the effort, because there was no motivation." While she agreed that students could do well if they put effort in, she put the burden of motivating the students on the instructors. She felt that the motivation to put in the effort, was lacking in this course.

The TA participants noticed that reading the book and doing practice questions was a trait of their higher scoring students. John, one of the TAs, explained, "The students that were really on top of it, they read the book. There's, of course, not everyone, but there's people who read the book, listened to all the video lectures, did the homework, you know, killed it, for lack of a better word."

Ashley highlighted a different perspective on effort, saying, "It's like nobody would actually try to understand it on their own, which I think is just a thing with college students. You wait for somebody to actually get it, and then they'll kind of do it for you." From Ashley's outlook, if someone else could explain it, then it was possible to learn from that. Why would she put in more effort than she had to?

Several of the TAs encountered students with similar attitudes. Leah, the TA, had a student who came to her office hours regularly looking for answers. She shared, "You know, she wanted the homework answers, right? So she was always in there. But it went from at the beginning her doing almost nothing to her doing basically all the work and me just kind of sitting there reassuring her that she was doing the right thing." Leah noticed that as time went on, this student who only wanted to be told the answer, started to do the work on her own, simply seeking reassurance from her TA.

Chloe, another TA, also recognized, "There was always the issue of some students just wanting it told to them as opposed to going on and doing the extra work."

Isabella shared an experience she had that illustrated how a change in her effort resulted in better performance. She explained, "If the people only rely on the videos, I don't think that they do good on the quizzes, because I didn't do good on the quizzes in the first weeks when I was only watching the videos, but when I started reading I started to do well." She started to put more effort into learning the material by reading the textbook, and as a result she started doing better on the quizzes.

Students believed that they were putting effort in to the course and expected this effort to be reflected in their grades. Many students became frustrated when this was not the case. These students felt that no matter what they did, they could not achieve the scores that they wanted to.

6.2.6 Perceptions of Task Completion Over Learning Concepts

The code *task versus learning* is defined as statements that indicate a focus on completing a task rather than learning concepts/science/materials/etc. (see Table 6.2 for definitions). Students appeared to be more concerned about the tasks that they were required to complete in the course, rather than learning the material.

The most important task centered around maintaining their GPA. Megan explained, "I think that everyone was so caught up with their grade that would be affected and the points that they're missing"

Ashley also highlighted this with her simple statement, "GPA's all that matters." She went on to share, "I looked at my grade once, and I was like, 'Oh, I passed. I'm good.'" Her concern was not about learning. All that mattered was that she completed the task of passing the course.

JoJo highlighted her intent going into the course, sharing, "I was trying not to get a D. Actually my aim was to get an A in the beginning. You know how every students is, and then I was like, 'It's fine I'll settle for a B. That's okay.' And then I ended up getting a C." She made no mention of learning in the course. Everything she said was centered around her grade.

When it came to the recitations, Harold described that "it was solely focused on who was going up there and who was presenting, and zero emphasis on who understood it or who got it right."

Megan also shared, "I would go in recitations that day nervous that I'd get called on because I didn't know what I was doing necessarily, and I would try to get through the questions as fast as I could with as little mistakes as possible, and then just get out of the lecture so I could get out of that class and learn it myself." Megan and Harold both perceived their time in recitation as being about not failing at a task, rather than learning the material.

Megan went on to share an account of how she specifically engaged with the presentations. She described:

> *Let's say I was called up. We'd get done working the problem, and then I'd be so focused on, this will make sense whenever I come back. […] They'd want you to go up and explain it yourself and you could use the prompt up on the board, but they didn't want you using the white board in the center, they didn't want you using your notes. So I was so focused on memorizing what I had already written in the two minutes that we had to write it all down, that I wouldn't learn. I'd be memorizing and then forget it in the next two minutes. Or if I wasn't called on, I'd be like, "Oh, thank god." And then forget what I just memorized. I'd be so focused on remembering my steps that I took to get to the answer, not understanding why we did those steps.*

Megan was so preoccupied with memorizing what to present, she felt that she was unable to take the time to understand why she was doing those steps in the problems.

Leah, one of the TAs, was particularly frustrated by students' attempts to simply memorize the material and the educational system's promulgation of that mentality. She explained:

> *I think so much of education now is just like, you know, put it in, forget it after the exam. Put it in, forget it after the exam. […] I seriously can't even count the number of times that I said, "Quit memorizing it. Like, stop trying to remember what you did last time. Or what you did on the homework or*

163

whatever. Like, stop trying to remember what you did and look at this through a new lens. This is a new problem."

Leah attempted to stifle this approach to the course in her students and hoped that it would help them in their future courses.

When it came to working with TAs during recitation, Harold recounted:

> *The TAs were just relying on the solution manuals that they had gotten, and kind of working through it. Which sometimes that was what I needed, because I just needed to get through one step of it. And if they had the solution, they could get me over the hump. But it wasn't instructional. It was just verbatim, "Oh, multiply by that. Divide by that."*

Again, Harold brought into focus the attitude of task completion over instruction that would lead to understanding.

The TAs also recognized that their students focused on simply getting the answer. Chloe explained, "There was always the issue of some students just wanting it told to them as opposed to going on and doing the extra work."

Leah shared this perspective as well, describing, "There are so many students who just want you to give them the answer, right? Like, I would say a majority just want the answer and they want to memorize it and get out. Like, they don't care about the learning process."

Ashley summed up the attitude of the students best, asserting, "We're just here to get degrees, not really work for them." Ultimately, it was about completing classes in order to get certified in their majors, not about learning the content associated with their majors or the classes.

According to some of the TA accounts, some aspects of the course and TA behaviors reinforced this idea as well. Leah observed that the way some TAs cultivated their environment affected the learning atmosphere. When reflecting on an observation of another TA's laboratory session, she shared, "I don't think the atmosphere was one to like excite learning. It was more like, 'Okay. Get in, get your stuff, get out. I don't want to see you any longer than I have to.'" Leah witnessed an environment where she felt that students were motivated to complete the task and leave as quickly as possible.

Chloe, another TA, described that the recitations seemed to be more focused on getting through the problems, rather than making sure that students understood the material. She explained:

There were always sometimes those questions where [the instructor] *really wanted to get to the next question but* [the students] *really weren't ready to get to the next question, like a significant number. It was a time issue with the class, how much time we had in the class and also the fact that he needed to get to the next question so that they would be prepared for an exam or something like that.*

While she acknowledged that the instructors had the best of intentions, Chloe recognized that there was an emphasis on getting through the questions, rather than instructing the students.

Overall, students focused on completing the tasks associated with the course rather than learning the material. Some accounts revealed that this was a perspective that students came into the class with, while others demonstrated how the course structure and agents exacerbated the perspective.

6.2.7   Time of Class

The code *time of class* is defined as statements identifying the time that the class was held (see Table 6.2 for definitions). Students frequently mentioned the time that they met for their recitation and would occasionally credit that as a reason for aspects of their performance. A summary of the times that each participant (student and TA) attended the recitations is provided in Table 6.3.

Most comments about the time of the course, came from students who had recitation at 7:30 am on Tuesday. As one might expect, these comments focused on the fact that it was early in the morning. Students claimed that they were barely awake, and their TAs appeared to feel the same. During the focus group discussion, Harold described his TA's coffee routine, saying, "Yeah, I feel like, cause it was 7:30, if you tried to ask a question before half of her coffee cup was gone, it was just not very effective."

Other students continued to comment on how early it was during their interviews. When addressing the help that she had trouble getting in class, Chelsii claimed, "maybe because my recitation was 7:30 on Tuesday mornings, everyone's dead tired."

Ashley made a similar comment, proposing, "My recitation was at 7:30, which is probably why I didn't do well."

Harold remarked on his energy in the morning, observing, "There's not that much enthusiasm I had left after four years to be taking a hands-on course at 7:30 in the morning."

Table 6.3. Participant Recitation Section Time. The times that each participant was assigned to attend recitation for this course are outlined in the following table.

Participant	Student/TA	Time of Class
Harold	Student	7:30 am on Tuesday
Ashley	Student	1:30 pm on Friday
Megan	Student	7:30 am on Tuesday
Chelsii	Student	7:30 am on Tuesday
Isabella	Student	3:30 pm on Friday
Max	Student	3:30 pm on Friday
Pete	Student	3:30 pm on Friday
JoJo	Student	Could not remember
Leah	TA	7:30 am on Tuesday
John	TA	1:30 pm on Friday & 3:30 pm on Friday
Susie	TA	7:30 am on Tuesday & 3:30 pm on Friday
Chloe	TA	7:30 am on Tuesday & an afternoon

The TAs also recognized how their abilities changed between the different times they taught. Chloe explained, "I had a 7:30am one and then I also had an afternoon one and I remember being really awake and really ready for the afternoon one. I was like, 'Yeah, let's do this,' and then the morning one, I was like, 'Okay, guys. Let me drink one more cup of coffee.'"

Susie, another TA, provided a similar account. She shared:

> *I had the very first recitation section, so a lot of times that was the one where you work out all the problems and stuff, and see which problems work, which ones don't, which one students take a lot of time for, which ones students fly through, and then it gets adapted for recitations later in the week. I had the very last recitation offered as well, so my Tuesday morning students were ... They usually took a long time with the problems, and working through it. But it seemed like my Friday section always flew through it.*

166

Susie acknowledged the effects that the time could have on her students and recognized that the first group, on Tuesday mornings, may have been slightly disadvantaged, simply because they were the first group. Given that most of the student participants were in this category, it may be important to keep this in mind.

Students identified that the early morning session may have had an influence on their abilities to perform in the course. The acknowledged that this could be a result of their own fatigue, or potentially the weariness of their instructors and TAs, who were still in the process of "waking up" when they met for class.

6.3   Summary

The events and activities that students engaged with as part of the course had an influence on their perceptions and motivations. The chemical demonstrations were generally enjoyed and evoked excitement for the topic of chemistry, while the presentations were met with stress and anxiety. The way that time was managed during the sessions also left most students dissatisfied and feeling that there was either too much time or too little time provided to complete the in-class work. When it came to studying, students identified numerous resources and techniques, but the TAs observed that students who performed the best tended to utilize a combination of the resources provided by the instructor and prepared questions to ask the TAs during the recitation. In addition, students believed that they were putting effort into learning the material and were frustrated when their grades did not reflect their perceptions of their investment. While they believed that they were trying to learn the material, most of their comments illustrated a focus on completing the course tasks rather than understanding the concepts.

CHAPTER 7.   DISCUSSION: CHARACTERSITICS OF THE FLIPPED APPROACH THAT INFLUENCE STUDENTS' MOTIVATIONS

In the results chapters, data were presented that identify various features of the course that influenced the motivation of students. Some of these features were corroborated by TAs. The following sections discuss assertions that can be made in response to the results presented in the previous chapter. The assertions may be in the form of an overarching statement that summarizes the nature of the feature being discussed, or may be in the form of a recommendation to addresses the thwarting characteristics of the feature in future iterations of the course. Some of the sections also discuss how these features supported or thwarted students' needs, prior to presenting an assertion. The assertions and characteristics of each feature are outlined in Table 7.1.

7.1   Student Presentations

Throughout the study, participants indicated that the presentations in the class had considerable influence on their perceptions of the course and the way they engaged with it. Those who enjoyed the presentations felt like they were able to demonstrate competence, while those who did not were worried about demonstrating a lack of competence and the ramifications that came from it.

7.1.1   Supporting Characteristics of Presentations

The presentations provided an opportunity for students to demonstrate their understanding. When they knew how to solve the problem students found it exciting. In the results chapter, Ashley described how she wished she could have presented more often. She described her excitement at solving the problem and even had a friend video record her presenting so that she could send it to her parents.

According to self-determination theory, this is an example of a competency supporting feature of the course. In this example, Ashley was able to satisfy her need for competence in a way that allowed her to feel a sense of "confidence and effectance in action," (Ryan &Deci, 2002, p. 7).

Table 7.1. Summary of Supporting and Thwarting Characteristics of Course Features and Assertions.

Course Feature	Supporting Characteristics	Thwarting Characteristics
Student Presentations	Supports sense of competence when student understands the concept	Thwarts sense of competence when student does not understand the concept
		Points imposed controlling effect
		Lack of TA engagement thwarted development of competence
		Success was perceived as something outside of students' control no matter how much effort they invested
	Assertion 1: Presentations would better support student needs if presenters are given a few minutes advanced notice to prepare.	
Group Work	Supported camaraderie with peers	Instability of groups thwarted the development of relatedness to peers
	Supported ability to demonstrate competence on future assessments	Lack of ability or willingness to communicate information thwarted the development of competence
	Assertion 2: Group work in a flipped learning environment should provide students with a stable sense of relatedness and a sense of closure.	
Lecture Videos	Ability to choose what to study and when supported autonomy	Low quality of videos modeled perceptions of low effort of instructors, which students imitated
		Perceived misalignment of video content to course assessments thwarted sense of ability to develop competence
	Assertion 3: Online lecture videos can support student autonomy, but perceptions of low quality can thwart other aspects of student motivation.	

Table 7.1 continued

Grading	Assertion 4: Students' self-concepts and perceptions of the grading system thwarted their sense of competence in the course.
Demos	Assertion 5: Demonstrations provide unique features that support an environment where intrinsic motivation can be fostered.
Personalization of Examples	Assertion 6: Examples and questions that attempt to demonstrate the applicability of the course content, should also demonstrate practicality for the students.
Student Interactions with Instructors and TAs	Assertion 7: Students have more positive perspectives when a TA is transparent about particular activities in the course.
	Assertion 8: Instructor and TA attitudes can influence how students choose to engage with the course.
	Assertion 9: TAs must be provided with relevant resources well in advance of their needing to use them in a flipped course.
Student Goals	Assertion 10: Student goals in a flipped learning general chemistry course are focused on getting a good grade and completing the tasks.
	Assertion 11: The course structure and the actions of the TAs and instructors create a culture of performance oriented goals rather than mastery-oriented goals.

The opportunity to stand in front of people and demonstrate one's effectiveness has the potential to support the students' need for competence, and thus stimulate a greater internalization of their motivation. However, this is only the case if the student feels that they were able to complete the task in an effective manner. If a student leaves the activity was a sense of failure, their sense of competence will have been thwarted.

In the case of the presentations, the participants most often reported that they experienced the stress of trying to "not look incompetent," rather than the satisfaction of feeling competent.

7.1.2 Thwarting Characteristics of Presentations

The majority of student perceptions of the presentations illustrated a thwarting of their needs according to self-determination theory. Presentations were perceived as a way to punish incompetence rather than support competence.

The points associated with the presentations had a controlling effect on students, which can stimulate an externalization of motivation. Because of the way that points were given to the group based on a single student's presentation, students felt a responsibility to do well for their peers' sakes. This responsibility is an example of an external regulation for extrinsic motivation. The student does not feel as though they have a choice. They are being directed to do an activity and if they refuse to do it or do not do it well, then they and their team are punished.

In addition to the controlling nature of the presentations, there is also evidence of their competence thwarting effects. Whether it was nervousness about language, the fear about letting your group down, or plain anxiety, students' attitudes toward the presentations thwarted their sense of competence in the course. Students' self-concepts, defined by Pajares and Schunk (2001) as perceptions of one's self-worth and ability to perform tasks competently, appear to have a competency thwarting effect on students' motivation with regard to presentations.

The structure of the presentations either reinforced the preexisting self-concepts, or did nothing to remediate them. In some cases, the TA's lack of engagement with a student's presentation thwarted the students' potentials to develop competency. Student participants, like Megan, expressed their dissatisfaction with the fact that she never knew if she presented the problem correctly or how to correct the mistakes she might have made. In situations similar to this, students are unable to develop their competence. If they are unable to use these tasks to develop skills that will help them to efficiently interact with their environments, then it leaves them

wondering why they should engage in the task in the first place. The students continued to engage with the tasks because of the points associated with them, which have a controlling effect.

A specific problem that students also identified was that even if they engaged with their group, there was still a possibility that they could lose participation points because someone did poorly in the presentation. According to the attribution-based theory of motivation, students attributed the points that they would receive from presentations to an unstable, external, uncontrollable entity (Weiner, 1986). What this means is that the students perceived the results of the presentations as something that was inconsistent, beyond their own control, and external to themselves. The key here is that it affects them, but is something that they are not in control over, which has a thwarting effect on the students' perceived autonomy.

7.1.3   Assertion 1: Presentations would better support student needs if presenters are given a few minutes advanced notice to prepare.

Rather than being a platform upon which students had the opportunity to demonstrate their competence, the presentations were most often perceived as a way to punish their incompetence. A recommendation that could help to alleviate some of this antipathy was proposed by one of the TA participants named Leah. She suggested that the students be given a few minutes to prepare for the presentation and ask any final questions they have of their peers and their TA before going up to present.

This would help to support the needs that the students perceived as being thwarted. By being given an early warning, the students may feel as though they have more control over their performance and can demonstrate greater competence.

7.2   Group Work

As one would expect, the novel collaborative nature of the recitations had an influence on students' perceptions of the course. The group dynamics and the in-class questions appeared to have the most significant influence on the students.

7.2.1   Supporting Characteristics of Group Work

A seemingly obvious influence of group work comes in the form of the social dynamics. The students enjoyed the ability to sit together with their peers and work on the problems together. Pete and Ashley in particular, highlighted the camaraderie that developed during their time working with other students. This activity supported students' needs for relatedness, which can reinforce internalized, and even intrinsic, motivations.

The student participants also acknowledged that the in-class questions were useful when it came to the exams. They were able to develop their competency by working on these problems and actively chose to engage with the task to improve their ability to perform well on the exams. This is an expression of identified regulation of motivations, where individuals choose to join in an activity because of the activity's potential utility value (Ryan & Deci, 2002).

7.2.2   Thwarting Characteristics of Group Work

While the group work was able to support aspects of relatedness and competence, various aspects of its execution in the classroom, thwarted students' needs as well.

When it came to working as a group student participants identified flaws in how some of the groups worked together. In some cases there appeared to be a belief that there were too many students who did understanding the material, or the few students who have the knowledge either did not have the ability to communicate it to the rest of them or they simply chose not to. Chelsii's description of the competitive nature of academia may explain why some students actively chose not to collaborate.

For those who did know and tried to help their peers, they came across as domineering. Susie, one of the TAs, even described these students as dominating the discussion, while the other students just sat there. This hinders other students from being able to demonstrate competency and thwarts the ability to satisfy this need.

Student participants also expressed their dissatisfaction with the changing of groups. Not only did this disrupt their ability to maintain a sense of relatedness, but it also hindered their competence. JoJo described this best when she explained that they would switch groups just as she started warming up to people. She would have to redevelop this sense of relatedness with a new group of people before she felt as though she could satisfy her need for competence.

As for the in-class problems, students and TAs acknowledged the absence of a resolution for the problems that the students were working on. A subset of both student and TA participants claimed that more often than not, there would not be enough time at the end of student presentations to provide feedback or corrections to the problems. On rare occasions the instructors might do this with the entire class, but the TAs explained that this was not a normal occurrence. This lack of "closure," left students without a sense of being able to move forward with competence in the concepts they were supposed to have learned.

7.2.3 Assertion 2: Group work in a flipped learning environment should provide students with a stable sense of relatedness and a sense of closure.

It is apparent that switching of groups caused a sense of disrupted relatedness for some student participants. By providing opportunities for students to choose a "buddy" that they could stay with during each change, the sense of thwarted relatedness might have been mediated. This approach could also provide a support for autonomy in that it introduces agency in how the students are able to engage with the course.

The lack of closure on some problems created significant frustrations in some student participants. The importance of providing closure on problems was impressed upon me as a supplemental instruction leader in college. Providing some way to "ensure that students do not lose sight of the 'big picture,'" is an integral part of the supplemental instruction model (The Center for Academic Development, 2006). The student regularly expressed their desires for the instructors to "actually teach" the course. This feeling was only exacerbated by instances where students were seated towards the middle of the room while the instructors assisted on the periphery.

Simply having an opportunity for the instructor to summarize the lesson at the end of each session and allowing students to ask questions, could remediate these frustrations. Since it appears that the students view the instructors and TAs as the source of knowledge, it may be useful to provide a time in the session that explicitly reinforces the learning that is supposed to happen during the collaborative work. This could satisfy the students' perceptions of developing competency, while providing an overview of the lesson.

7.3 Lecture Videos

Students and TAs both put in varying degrees of effort when it came to watching the lecture videos. The content and quality of the videos were mentioned during the study and contributed to students' motivations in different ways.

7.3.1 Supporting Characteristics of Lecture Videos

Since each video was about a specific topic, students, such as Pete, were able to focus their efforts and choose what topics they wanted to study or go back to later on. The TAs also appreciated that they could choose the topics that they needed refreshers on, rather than sit through a 50-minute lecture. The structure of these videos supported students' autonomies by allowing them to choose what they wanted to study and when they want to study it.

7.3.2 Thwarting Characteristics of Lecture Videos

Although the videos supported the students' autonomies, the quality, and even the content at some points thwarted their sense of competence. Although the video content should be more important than the quality, students expressed their distaste for the quality and shared how it influenced their engagement with the content.

At a superficial level, students shared their experiences with the blurriness of the lecture videos and the mannerisms of the professors in the videos. Harold in particular shared his frustrations with the way Dr. Bradley would write in circles, which made it hard for him to understand what was going on. At one point, Harold shared that he stopped watching the videos and just printed out the lecture slides because he could at least turn the papers around in order to read the notes properly and they were not blurry. The seemingly disorganized and low video quality, made students feel as though they had to put in more effort to follow along with the lecture videos. The students did not believe that they could efficiently use the videos to develop their competence. They did not feel as though they were not able to effectively interact with this medium of learning, which can have a thwarting effect on their need for competence.

In addition to the video quality, students, and even a TA, noticed that some of the videos had dogs barking in the background and were date stamped for 2015, which was two years prior to this iteration of the course. According to Bandura's Social Cognitive Theory, much of what

people learn comes from observing, what the literature refers to as models (Rosenthal & Zimmerman, 1978). In this case, the instructors and TAs can be considered models of how students engage with the content. One characteristic of effective models is that they have credibility. A model who is credible, behaves in a way that is consistent with their teaching (Bandura, 1986). If an instructor expects students to put forth effort in the class, but the behaviors that students see do not model that effort, then the desired behavior is less likely to be emulated. The modeled effort of the instructor may not be representative of the instructor's actual effort, but it is the behavior that the students noticed. As a result, students, like Harold, were less motivated to put in the effort to engage with the videos, since it appeared as though the instructor did not put much effort into creating them in the first place.

Finally, with regard to the content, the students mentioned a few occasions when the videos did not appear to align with the quizzes during the recitations. They claimed that their quiz scores suffered because of it. When this occurs multiple times, it may stimulate the perception that the videos are not able to support the students' abilities to perform well in the course. This is an example of competency being thwarted.

7.3.3 Assertion 3: Online lecture videos can support student autonomy, but perceptions of low quality can thwart other aspects of student motivation.

Even though some of the student participants expressed their appreciation for the autonomy that they were provided in the lecture videos, students' motivations were still thwarted as a result of the quality of the videos. Instructors who want to use online videos as a substitute for in-class lectures, should be aware of how their delivery of the content influences students' willingness to engage and how their effort may be perceived by students.

7.4 Grading

Grades naturally have a controlling effect on students as they are a form of external regulation that prompts students to complete tasks in order to earn a reward or avoid punishment. Rather than discussing facets of this feature that support and thwart students' motivations, this section will support an assertion that discusses how specific aspects of grading in this course appeared to uniquely thwart students' basic psychological needs and how certain aspects of students' expectancies thwarted their motivations.

7.4.1 Assertion 4: Students' self-concepts and perceptions of the grading system thwarted their sense of competence in the course.

Students carry with them expectations from previous courses, even previous flipped courses. Their experiences with science in high school, or even earlier, influence their beliefs about their capabilities to perform tasks successfully, also known as expectancies (Wigfield & Eccles, 2002). During this course, some of these expectancies were exacerbated, or shown to be incorrect on enough occasions that the students attributed their performance to something that was external, stable, and uncontrollable (Weiner, 1986).

Students, such as Ashley, brought with them the beliefs that they always get the same grade in science and that there was nothing they could do to change that. Students who have these expectancies, attribute their performance to something that is stable, uncontrollable, and internal. Weiner (1986) explains that this combination of attributes comprises students' beliefs about their aptitude. This can also be described by Dweck's (2006) theory about "fixed mindsets" where students believe their abilities to be a "fixed" characteristic that they do not have control over. This approach to tasks in the course, can lead to less effort since the student does not believe that their efforts will cause any change in their performance (Dweck, 2006).

Students like Megan witnessed that despite having a tutor and using the resources available (i.e., Supplemental Instruction) they continued to receive poor grades on the tasks required for the course. This is different from the perspectives of students like Ashley, in that the attributes are external to the student rather than internal. Weiner (1986) explains that this combination of attributes may be related to the students' perceptions of the difficulty of the course requirements. For Megan, it was not that she could not learn the material, it was simply that the tasks were beyond the skills that she had developed.

Both Megan and Ashley represent a group of students who felt that no matter how hard they tried they could not get higher grades. The continued thwarting of their sense of competency in this way decreased their self-concepts with regard to chemistry, which can result in a learned helplessness (Ulusoy & Duy, 2013). This helplessness leads students to essentially give up because they have learned that effort is more costly than the reward (Teodorescu & Erev, 2014) and that their actions have no effect on the outcome (Ulusoy & Duy, 2013).

Students identified that the grading system felt as though it deducted points for small mistakes, rather than awarding points for success. This provided little room for error and led to much frustration for the students.

Harold and the TA, Susie, both expressed their displeasure with the way points were deducted in various aspects of the course. Harold explained that while he got an answer correct on an exam, he still lost a significant amount of points because he did not include units in his work. His friend, however, received almost full credit for simply describing what he might do for the same problem. Harold eventually described that he had given up at some point during the class because, like Ashley and Megan, he felt that no matter how hard he tried, there was always going to be something that he did wrong.

7.5   Demos

The "flashy" nature of chemical demonstrations naturally has an influence on student motivation. The data described different ways that the demonstrations influenced students' perceptions of the course. Rather than discussing facets of this feature that support and thwart students' motivations, this section will support an assertion that discusses how the students' motivations were influenced by the demonstrations.

7.5.1   Assertion 5: Demonstrations provide unique features that support an environment where intrinsic motivation can be fostered.

Literature on chemical demonstrations in the classroom has indicated that the "exocharmic" (Ramette, 1980) nature of these demonstrations has been shown to inspire students in the chemistry classroom (Meyer, Schmidt, Nozawa, & Panee, 2003) and can influence student learning of the material (Baddock & Bucat, 2008; Velazquez-Marcano, Williamson, Ashkenazi, Tasker, & Williamson, 2004).

In this study, students expressed their perceptions of the demos as interesting, and Megan even described how they were useful because they helped to illustrate the concepts. JoJo and Isabella, in particular, highlighted features of the demonstrations that supported characteristics of intrinsic motivation. They highlighted that the demonstrations made them think that it would be "fun" to be chemists and do demonstrations like the ones performed by the instructors. They did not desire any separable outcome from the demonstration; only to perform them. The satisfaction

that was inherent to the *process* of performing the demonstration was independent of any separable outcomes of that activity. The students' desires highlighted their sense of curiosity and fantasy (Lepper & Hodell, 1989).

Curiosity is defined as a "form of cognitively induced deprivation that arises from the perception of a gap in knowledge or understanding," (Loewenstein, 1994, p. 75). While it is uncertain whether their desires came out of a deprivation of knowledge, it is certain that the students' desires came out of a sense of deprivation of experience. JoJo and Isabella, felt a sense of curiosity to satisfy that deprivation.

Fantasy is defined as activities that involve simulations that present students with situations that are not actually present (Lepper & Hodell, 1989). Students who are able to identify with a character (the instructor) can "derive vicarious pleasure not ordinarily available to them," (Schunk, Meece, & Pintrich, 2014, p. 268). The situation presented is a "flashy" experiment, where students "derive vicarious pleasure" by observing their instructor performing it. For JoJo and Isabella, they were able to identify with the instructor as a chemist by entertaining the notion that they could become chemists.

The presence of demos created a sense of curiosity and fantasy in students like JoJo and Isabella. The presence of these features associated with the demonstrations provided a space that fostered the potential for intrinsic motivation related to the course.

7.6   Personalization of Examples

It would make sense to assume that people will be more inclined to engage with tasks when they can see the direct application to their own lives. In self-determination theory, this is called identified regulation of motivation (Ryan & Deci, 2002). In this study, students expressed their desire that content be delivered in a way that they could see how they could use it in their lives and/or their career. This section will discuss an assertion that addresses this desire.

7.6.1   Assertion 6: Examples and questions that attempt to demonstrate the applicability of the course content, should also demonstrate practicality for the students.

Even though some of the topics were presented in a way that showed their applicability, they lacked practicality for some of the students. Students, such as Harold, were able to draw their own connections between some of the concepts and their own personal life. Students like Chelsii,

however, appeared to be unable to make these connections on their own, and their frustrations with the course only increased when the in-class applications lacked practicality. In the results chapter, Chelsii expressed her irritation with the questions related to the environment. She explained that it might have application for an environmental scientist, but it had no practical function related to her or her career.

Whether they can come up with the connections or not, students want examples of direct and practical applications of the content to their own lives. If students are unable to acknowledge the value that the content has for their own lives, then they may be less likely to choose to engage in the activities associated with it (e.g., homework, lecture videos, note-taking, etc.).

In addition to the concepts in the course, some of the TA participants noticed that pointing out practical applications (i.e., skill and content) created better student engagement. The skills developed from working with the content can also be used as examples of the practicality of the course content.

In a flipped learning environment, there are unique opportunities to provide online resources (e.g, YouTube videos) and in-class discussion that help to illustrate the applications of certain skills and content to the reality. This provides students with the an awareness of the utility value of the course, where utility value is the usefulness of a task for future goals (Wigfield & Eccles, 1992).

Taking the time to highlight how certain skills associated with course content can be applied to the "real world," may help students to recognize the utility value of the course and thereby develop a more internalized sense of motivation in the form of identified regulation (Ryan & Deci, 2002).

7.7   Student Interactions with Instructors and TAs

Instructor and TA behaviors had an effect on how students perceived and engaged with the course. Their attitudes communicated to students whether or not it was okay to ask them questions, and there is evidence that when a TA was transparent, the students felt more comfortable engaging with them. There were also accounts that stressed the importance of ensuring that TAs are provided with the relevant resources prior to their needing to use them.

7.7.1 Assertion 7: Students have more positive perspectives when a TA is transparent about particular activities in the course.

In the study, students expressed moments where they received explanations from their TAs that helped them to feel more positive about the course. An example of this is Harold, who shared that he took out his frustrations with his exam score on his TA. When she explained that she was simply following a rubric, he relented and felt a restoration of the relatedness with his TA.

Alternatively, Max shared an experience where he felt frustrated because his TA would not directly answer his question. It may have helped his perspective if the TA was more transparent and explained that their job was to help him learn not just to give him the answer.

In Max's case, he felt as though his competency was being thwarted by the TA's apparent refusal to provide a satisfying answer to his questions. Harold, however, felt better after his TAs explanation, not because his competency was no longer thwarted, but his perception of relatedness to his TA was restored. In both of these cases, TA transparency had the potential to promote a more positive perspective of the course.

7.7.2 Assertion 8: Instructor and TA attitudes can influence how students choose to engage with the course.

It is apparent that students valued their relationships with the instructors and TAs, even in the midst of their frustrations with the course. The student participants frequently described their sense of comfort with instructors and TAs as well as their appreciation for how much the course staff seem to care about them.

The participants expressed their appreciation for the enthusiasm and genuine concern of the instructors. The students felt that these traits helped to create a positive atmosphere in the midst of a difficult course. Participants were also conscious of the patient, gentle, and nonjudgmental nature of the instructors when students asked them questions. These characteristics helped the instructors to create a safe place for students to ask them questions, especially for students like Megan and JoJo, who felt that their peers were not a safe place. Despite their poor experiences in the course, student participants hesitated to blame the instructors because of their visible care and concern for the students.

TAs also had an influence on the students' perceptions of the course. The care and enthusiasm that TAs brought to their sections were noted by the participants. Some participants

noted how some TA behaviors had negative influences on their engagement in the course as well. Ashley recalled how the change in her TA's demeanor affected her section. She explained that part way through the semester he had become "mean" and got "rude and dismissive." She shared that her peers felt as though they had to walk "on glass around him" and did not feel comfortable asking him questions after that. She identified that the classroom atmosphere was different, and that students changed the way that they engaged with the course as a result of this shift in her TA's attitude.

Students also shared experiences that made them feel unwelcomed at TA office hours or discouraged from asking questions. Chelsii shared an encounter she had in office hours where she felt as though she was inconveniencing the TAs and said that she felt like they did not want her there. JoJo also shared an experienced where she witnessed the Head TA criticizing another student for not knowing how to do a question in class. She expressed that after seeing that, she was scared to ask questions during future recitations.

It is clear that instructors' and TAs' attitudes have an influence on how students feel that they can, and should, engage with aspects of the course. Teachers who are understanding and welcoming to students, promote behaviors that helps students to succeed, while teachers who are overly critical and make students feel like burdens, prompt students to avoid resources and behaviors that could help them to succeed.

7.7.3 Assertion 9: TAs must be provided with relevant resources well in advance of their needing to use them in a flipped course.

Throughout the study, both student and TA participants were acutely aware of the TAs' lack of preparation as a result of administrative shortcomings. The students observed that the TAs appeared to be trying to understand the in-class questions alongside the students. The students, however, recognized that this was not their TA's fault, but the result of them not receiving the materials ahead of time.

This perception was confirmed by TA participants who shared that there were several occasions that they did not receive the material for the session until almost 30 minutes before the session started. This affected the TAs' abilities to assist the students during the recitations and led to student frustrations with not being able to receive the help they felt that they needed.

If a flipped course is going to be successful, instructors should have most, if not all, resources prepared before the semester begins so that TAs can access them and prepare for the questions students may ask. When this is not done, students and TAs are unable to feel as though they can interact efficiently with the learning environment. This results in a sense of competency being thwarted in both the students and the TAs.

7.8   Student Goals

An unexpected outcome of this study was the identification of student goals in a flipped learning environment and how the environment supported these goals. Chemistry student goals have been studied in the context of laboratory courses, but there remains a dearth of research in student goals for other aspects of chemical education (DeKorver & Towns, 2015). This is particularly true for students' goals in a flipped learning chemistry course.

7.8.1   Assertion 10: Student goals in a flipped learning general chemistry course are focused on getting a good grade and completing the tasks.

Most student participants, and even some of the TA participants, identified that the students' primary goals for the course were to maintain their GPA and get a good grade. Most of the time this involved getting the most points they could with the least effort necessary. Megan and the TA, Leah, illustrated this as memorizing the solution for the presentation, rather than trying to learn the material.

For students like Ashley and Harold, the goal of the class was simply to complete it. They viewed the class as another obstacle on their journey to getting a degree. Ashley even said, "We're just here to get degrees, not really work for them." Both Harold and Ashley were less interested in the content of the course, but more on the completion of the course.

One student, Pete, who enjoyed the course, recognized that the things he learned would help him to be a productive member of society later on. He expressed that one of his goals was focused on learning the material, so that he could understand it in the future.

The results illustrate that the majority of student participants had performance-oriented goals for the course. Performance oriented goals focus on demonstrating competence or ability and Dweck (1986) originally characterized them as a "bad" form of goal orientation. Alternatively, mastery-oriented goals focused on learning and mastering skills and was considered a "good" form

of goal orientation. In later studies Harackiewicz, Barron, and Elliot (1998) identified that both types of goals could be pursued together and deliver benefits. In Senko and Tropiano (2016) self-determination theory was applied to these goal orientations to account for the reasons for goal pursuits. These helped to explain why performance-oriented goals can have both negative (maladaptive) and positive (adaptive) effects.

According to Senko and Tropiano (2016), when a performance-oriented goal is pursued for autonomous reasons (e.g., fun, challenges, usefulness, etc.), the educational outcomes are positive, such as increased self-efficacy. However, when performance-oriented goals are pursued for controlling reasons (e.g., rewards, proving oneself, impressing others, etc.), then the educational outcomes are negative, such as avoiding help.

The data suggests that the student participants sought to perform well in the course in order to get a reward. This indicates the pursuit of performance-oriented goals for controlling reasons. In the language of self-determination theory, this is autonomy thwarting for the students and discourages internalization of student motivation.

7.8.2 Assertion 11: The course structure and the actions of the TAs and instructors create a culture of performance oriented goals rather than mastery-oriented goals.

Given that the research questions for this study were focused on the features of the course and students' perceptions of these features, it is unsurprising that the details of this unexpected research outcome would highlight how students perceived the course features that influenced their goals. The structure of the course, as well as the course agents (instructors and TAs), have an influence on what types of goals students will pursue.

The TAs in the course appear to exacerbate the students' focus on performing a task over learning the concept. Leah, one of the TA participants, described an experience where she briefly observed another TA's section during the laboratory session. She described the atmosphere as one where students felt like they had to "Get in, get *[their]* stuff, get out," and that the TA "*[didn't]* want to see *[the students]* any longer than *[they had]* to." This emphasized that importance of completing the task in lab over understanding the concepts of the lab.

The TAs approach to the in-class questions also promoted completing the questions rather than learning the material. Harold described how his TA would many times just tell him the steps in the problem. While he appreciated their help, he acknowledged that "it wasn't instructional." In

this moment, the TA is modeling the importance of completing the problem over understanding the concepts that lead to the solution.

The presentations that came after the in-class problems, made students nervous about losing points for deficient performance. This promoted short-term memorization of the in-class problems, rather than attempting to understand the concepts and how they were being applied.

Each of these accounts are examples of thwarting mastery-oriented goals. The students were not encouraged to take their time in lab, on the in-class questions, nor to prepare for the presentations. The emphasis was on getting each of these tasks done, which disincentivizes mastery-oriented goals.

These accounts also illustrated controlling effects over the students. The student participants did not express desires to do any of these activities out of their own volition, but in a desire to earn the points associated with the task or avoid the shame associated with not doing well.

The course structure and the behaviors of the course agents are the result of a culture the emphasizes grades over learning. The agents of the course believe that grades are indicative of what students have learned, when in reality it appears that most grades are a reflection of how well most students memorized the content. While memorization may be a useful skill, it is generally not a learning objective for chemistry course. In order to change this culture of completing tasks over learning concepts, the instructors must create spaces where students do not feel pressed for time or controlled by points. The instructors need to include tasks that are perceived as low risk for students and promote the utility and practicality of the skills associated with those task (as highlighted in Assertion 6).

7.9   Summary

One of the intentions for conducting this course in a flipped format, was to give students more freedom in their learning. However, many of the course activities were designed to hold students accountable to their work in a way that made students feel controlled, thereby undoing the sense of freedom that students were supposed to be experiencing with the flipped format.

The features that students spoke positively about supported their basic psychological needs of relatedness, competency, and autonomy. When students were frustrated with the course, the features that contributed to this frustration were associated with the thwarting of their basic psychological needs, particularly the needs of competency and autonomy.

Many of these "needs-thwarting" features have the potential to be remediated in the future, but require a substantial redesign of various course components, such as the grading structure, the presentations, and the in-class questions. However, because the students who enjoyed the course were able to highlight moments where their needs were supported, and could overlook the controlling aspects of the course, there is evidence that mitigating the "needs-thwarting" features could improve students' experiences in future iterations of a course like this.

7.10   References

Baddock, M. and Bucat, R. (2008). Effectiveness of a classroom chemistry demonstration using the cognitive conflict strategy. *International Journal of Science Education, 30*(8), 1115-1128.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

DeKorver, B. K. and Towns, M. H. (2015). General chemistry students' goals for chemistry laboratory coursework. *Journal of Chemical Education, 92*, 2031-2037.

Dweck, C. S. (1986). Motivational processes affecting learning. A*merican Psychologist, 41,* 1040-1048.

Dweck, C. S. (2006). *Mindset: The new psychology of success.* New York: Ballantine Books.

Harackiewicz, J. M., Barron, K. E., and Elliot, A. J. (1998). Rethinking achievement goals: When are they adaptive for college students and why? *Educational Psychologist, 33,* 1-21.

Lepper, M. R. and Hodell, M. (1989). Intrinsic motivation in the classroom. In C Ames & R. Ames (Eds.), *Research on motivation in education* (Vol. 3, pp. 73-105). San Diego, CA: Academic Press.

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin, 116*(1), 75-98.

Meyer, L. S., Schmidt, S., Nozawa, F., and Panee, D. (2003). Using demonstrations to promote student comprehension in chemistry. *Journal of Chemical Education, 80*(4), 431-435.

Pajares, F. and Schunk, D.H. (2001) Self-beliefs and school success: Self-efficacy, self-concept, and school achievement. In R. J. Riding & S. G. Rayner (Eds.), *Self-perception: International perspectives on individual differences* (Vol. 2, pp.239-265). Westport, CT: Ablex.

Ramette, R. W. (1980). Exocharmic reactions. *Journal of Chemical Education, 57*(1), 68-69.

Rosenthal, T. L. and Zimmerman, B. J. (1978). *Social learning and cognition.* New York: Academic Press.

Ryan, R. M. and Deci, E. L. (2002). 1: Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (3-33). Rochester, NY: The University of Rochester Press.

Schunk, D. H., Meece, J. L. and Pintrich, P. R. (2014). Chapter 7: Intrinsic motivation. In D. H. Schunk,, J. L. Meece, & P. R. Pintrich (Eds.), *Motivation in education: Theory, research, and applications* (4ᵗʰ edition) (pp. 237-272). Indianapolis: Pearson.

Senko, C. and Tropiano, K. L. (2016). Comparing three models of achievement goals: Goal orientations, goal standards, and goal complexes. *Journal of Educational Psychology, 108*(8), 1178-1192.

Teodorescu, K., and Erev, I. (2014). Learned helplessness and learned prevalence: Exploring the causal relations among perceived controllability, reward prevalence, and exploration. *Psychological Science*, *25*(10), 1861–1869.

The Center for Academic Development. (2006). *Supplemental instruction: Peer assisted study sessions.* Kansas City, MO: University of Missouri.

Ulusoy, Y. and Duy, B. (2013). Effectiveness of a psycho-education program on learned helplessness and irrational beliefs. *Kuram ve Uygulamada Egitim Bilimleri*, *13*(3), 1440–1446.

Velazquez-Marcano, A., Williamson, V. M., Ashkenazi, G., Tasker, R. and Williamson, K. C. (2004). The use of video demonstrations and particulate animation in general chemistry. *Journal of Science Education and Technology, 13*(3), 315-323.

Weiner, B. (1986). *An attributional theory of motivation and emotion.* New York: Springer-Verlag.

Wigfield, A. and Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12,* 265-310.

Wigfield, A. and Eccles, J. S. (2002). The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 91-120. San Diego, CA: Academic Press.

CHAPTER 8.   CONCLUSION: RECOMMENDATIONS FOR IMPROVEMENTS IN FLIPPED CHEMISTRY COURSES AND FUTURE RESEARCH

This research focused on investigating students' perceptions of the features in a flipped learning, second-semester general chemistry course that influenced their motivations in the course. What began as a generic qualitative inquiry into students' experiences with the course, eventually evolved into a phenomenographical study of students' perceptions of and motivations in the course. The results of this study have led to several assertions about student experiences and goals in flipped-learning, which can inform future implementations of this pedagogy in general chemistry courses and pose new questions that can be addressed in future research.

8.1   General Conclusions About Students' Motivations

Through the analysis of the data, it became apparent that different features of the course had a profound influence on how students engaged with the course. Students spoke positively about features that supported their basic psychological needs of relatedness, competency, and autonomy, while features that contributed to frustration with the course, were associated with the thwarting of basic psychological needs (Vansteenkiste, Lens, & Deci, 2006).

Students enjoyed the flexibility that the course structure provided, the genuine care for the students that the instructors exhibited, the stimulating displays of the chemistry topics during laboratory sessions and demonstrations, and the opportunities to foster new relationships. Not only did these features provide supports for the satisfaction of students' basic psychological needs but in some cases, they even fostered characteristics of intrinsic motivation, such as fantasy and curiosity (Lepper & Hodell, 1989).

Despite these supports, student and TA participants in the study, identified many features of the course that thwarted students' basic psychological needs and promoted maladaptive achievement behaviors. Most of these features, such as the presentations and in-class problems, incorporated controlling effects on students and reinforced negative self-concepts of competence and learned-helplessness.

Ultimately, the "needs-thwarting" features can be attributed to a focus on grades. Since student goals in this course appeared to be focused on getting a good grade and completing the

tasks, getting point deductions were seen as punishments and thwarted their sense of autonomy. The anticipation of getting these deductions stimulated students to focus on getting answers, instead of learning the concepts, which undermined their potential of developing competency.

While many of the course activities were designed to hold students accountable to their learning, these controlling features effectively undermined the students' "efforts to learn," replacing it with "efforts to complete." The next section will address how to respond to these "needs-thwarting" effects and what instructors can do to improve future iterations of the course.

8.2 Recommendations for the Improvement of Future Implementations

Many of the "needs-thwarting" features described above have the potential to be remediated in the future. The following sections address different aspects of the course that can be modified in order to promote more positive perceptions from students, while maintaining academic rigor.

8.2.1 Improvements to Presentations

The student participants in the study expressed a significant distaste for the presentations. The primary source of their displeasure arose from a sense of uncertainty. While students feared the prospect of looking incompetent in front of their peers and the possibility of losing points, these fears arose as a result of the seemingly random nature of the presentations.

The following suggestion to improve the presentations for future iterations was proposed by the TA, Leah. She suggested that the students who are going to present the in-class problem, be given advanced notice so that they can prepare and feel comfortable with the problem. She recognized that many students became distressed when they were chosen to present, and they had no time to regain their composure or organize their thoughts before they had to present.

By giving students a few minutes to gather their thoughts and prepare their presentation of their solution, students may feel a sense of agency over their presentation and view it as a demonstration of their competence, rather than a display of their incompetence.

8.2.2 Improvements to Group Work & In-Class Problems

While student participants enjoyed the opportunities to develop relationships in their groups and appreciated how well the in-class problems prepared them for exams, there were still features that obstructed their motivations. The rate of change in the groups, the absence of practicality for some of the questions, and the lack of the TAs' and instructors' preparation for the recitation were all observed and were a source of frustration for the student participants.

Some of the student participants expressed their discomfort with having to reestablish trust and working relationships with new groups every few weeks. For these students, it took effort to develop this relationship, and trust in group members did not come as easy to them as it may have for others. By allowing students to choose a partner who will remain constant throughout the changing groups during the semester, the instructor can introduce a support for each of the basic psychological needs. Be allowing students to choose their partner, a sense of agency is introduced to the course, which can support the students' sense of autonomy. For students who do not develop relationships as readily, having a source of constant support and comfort may help them to feel more confident in the groups, which can increase their self-concept and sense of competence. Finally, having an academic "buddy" that they continually work alongside of, may help to increase their sense of relatedness.

In addition to the groups, the students' found that the in-class questions and examples that the instructors were using, might be applicable to the real world, but they had nominal practicality for them as individuals. The student participants specifically expressed that they did not care about the environmental effects, nor did they care about different circumstances that would cause ice to melt. Student participants shared that they wanted information, examples, and skills that would help them in their careers. Even simple items that they could see, made the problems more relevant. The TA, Susie, shared that her students became interested in solving a thermodynamics problem about ice melting when they compared it to the tea that she always drank during the class. The study would be remiss, if it did not acknowledge the difficulty required to adapt questions that are applicable and practical for students. However, simply being aware of this when creating questions and incorporating props, such as Susie's tea, can help students to feel as though they are developing an ability to interact more efficiently with their environment, rather than dealing with abstract concepts.

Finally, it is clear that it is important to provide the TAs with the relevant resources for the course well in advance of their needing to use them, since the students can recognize when a TA, or instructor, is not prepared or has not been given time to review the necessary materials. When the TAs did not get the material they needed ahead of time, the students could tell. This frustrated both the TAs and the students, because the students did not feel as though they were being supported the way they should have been, and the TAs felt incompetent because they were not able to prepare for the students' questions. It is essential, and cannot be emphasized enough, that TAs be provided with the materials to support the students with enough time to prepare and understand the materials themselves. This may mean a late night for an instructor, but the TAs' lack of preparation as a result of receiving the materials the morning of the session, appeared to have a significant influence on the students' perceptions of the course. It should be evident that providing the TAs with the material earlier will help them to feel more confident and be more competent when helping students, which will help the students to feel more competent with the material.

By structuring the design of the groups and in-class problems in a way that supports students' autonomy, relatedness, and competence, the instructors can help students to experience greater internalized motivation and more positive perspectives of the course.

8.2.3 Improvements to Lecture Videos

Student participants expressed mixed reviews of the lecture videos. The qualities that they enjoyed or suggested as improvements (that did not include hiring a production team) were:

- Keep them topic specific
- Keep them short
- Provide example problems
- Do not use old videos
- Do not write in circles on the video screen
- Keep in mind that these are a reflection of the instructor's efforts in the eyes of the students

By keeping them short and topic specific, students are able to choose which videos they want to watch, when they want to watch them, and they can skip over the videos with material of which they already feel competent. This is a way to support students' sense of autonomy.

Providing example problems, allows students to confirm their understanding of the material and practice alongside the instructor. Providing these as a supplemental video that students can choose to watch in addition to the lectures, may continue to support autonomy as well, as well as competence.

Since the students perceive the videos as a reflection of the instructors' efforts, quality is a surprisingly important characteristic. The data illustrated that the student participants were frustrated by the apparent lack of effort that the instructors put into their videos. Writing in circles made it more difficult for students to follow and videos that were clearly made several years prior to the course continued to discourage student participants from taking the time to watch the videos. Videos should be revised to account for age, quality, and mistakes each year.

Ensuring that the videos support students' learning by presenting clear and concise content with options that supplement their learning, has the potential to lead to deeper engagement and more positive perceptions of the course.

8.2.4   Improvements to TA & Instructor Behaviors

Instructors' and TAs' behaviors influenced how students chose to engage with the course. A specific improvement that can be made to improve students' perceptions, is simply for instructors and TAs to be intentionally transparent in their decisions for the course. Student participants expressed frustrations when they did not understand why some TAs made certain decisions, and were satisfied when the TAs explained their reasons for them.

Ultimately, one of the most important things that instructors and TAs can do, is to begin dismantling the culture of performance-oriented goals. While these goals can promote achievement behaviors in students who feel agency to pursue them, the presence of points associated with their performance has a controlling effect on students (Senko & Tropiano, 2016). By promoting mastery goals, or goals that highlight understanding the material over reiterating the material for a grade, the course may be able to better support students' basic psychological needs.

Instructors and TAs have a profound effect on their students' perceptions. The way they demonstrate their views of the students and communicate their goals for students has a far-reaching influence on how students will respond to them and the course.

8.3 Recommendations for Future Research

This study provided students' perceptions of a flipped learning, second-semester general chemistry course. Although this research illuminated certain perspectives that students had about the flipped learning environment, as well as how these perceptions influenced their motivations, it also revealed new questions and opened doors for future studies. These will be outlined in the following sections.

8.3.1 Methods for future studies in students' perceptions of chemistry courses.

The methods employed for this study could be used to investigate the effects of the recommended improvements to future iterations of the course. Simply, implementing these improvements are not sufficient. It is important to continue to investigate whether these improvements have the intended effect on students' perceptions of the course, and if their implementation gives rise to unintended and potentially unobservable "needs-thwarting" effects.

8.3.2 Why did students believe that their freshman peers did better?

Although the idea that student participants believed that their freshman peers were able to perform better in the course, the reasons why are not apparent. Some student and TA participants observed that many of the freshmen in the course, seemed to engage more and perform better, and alluded to the fact that many of these students either had an AP version of chemistry while in high school or that they tested out of the first-semester general chemistry course. It would be interesting to investigate whether it was true that freshmen exhibited better performance in the course and, if so, why? This could provide insight into how to better motivate other students in the course and assist them during the tasks associated with the course.

8.3.3   How do TAs engage in flipped learning courses and why?

During the study, TA participants discussed how they interacted with the students and prepared their material. In some cases, they even described their reasoning for these behaviors. Since this was not one of the goals of this study, this kind of data did not emerge as a common theme from all TA participants. A study that directly addresses the reasons that TAs decide to employ certain styles when teaching a flipped learning course, may provide insights into how TA training programs can facilitate conceptual changes in TAs' understandings of teaching in different learning environments.

8.3.4   What do TAs believe about their students' abilities?

During the study, TA participants also discussed their beliefs about their students' abilities. These beliefs naturally led to decisions about how they would teach these students. Understanding why TAs hold these beliefs and whether or not these beliefs should be considered accurate reflections of their students' abilities, may reveal systemic biases that TAs bring to teaching students who come from different majors, in addition to possessing other demographic traits. The results of this understanding could provide further insights into how TA training programs can facilitate the development of skills that would help TAs to better recognize their own biases, in addition to the needs of their students.

8.3.5   What goals do students have when participating in a flipped chemistry course?

Since the characterization of student goals was not an intended outcome of this research, the results related to student goals may only be superficial. A study that can investigate the nuanced complexity of students' goals, may provide details that can illuminate the reasons that students engage in achievement behaviors and maladaptive behaviors. These results could lead to further interventions in the course that can address these goals and promote more positive perceptions of the course and greater achievement behavior.

8.4 References

Lepper, M. R. and Hodell, M. (1989). Intrinsic motivation in the classroom. In C Ames & R. Ames (Eds.), *Research on motivation in education* (Vol. 3, pp. 73-105). San Diego, CA: Academic Press.

Senko, C. and Tropiano, K. L. (2016). Comparing three models of achievement goals: Goal orientations, goal standards, and goal complexes. *Journal of Educational Psychology, 108*(8), 1178-1192.

Vansteenkiste, M., Lens, W., and Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation. *Educ. Psychol., 41*(1), 19–31.

PUBLICATION

Draft manuscript for publication

Insights into Student Goals in a Flipped-Learning General Chemistry II Course

Elijah Roth[†*], Christopher Randles[§], Adam Wasserman[†], Garth Simpson[†], George Bodner[†], Roy Tasker[‡], and Chantal Levesque-Bristol[¶]

5   † Department of Chemistry, Purdue University, West Lafayette, Indiana 47907, United States

§ Department of Chemistry, University of Central Florida, Orlando, Florida 32816, United States

‡ School of Science, Western Sydney University, Penrith, New South Wales, Australia

¶ Center for Instructional Excellence, Purdue University, West Lafayette, Indiana 47907, United States

ABSTRACT

10   Student-centered pedagogies have become increasingly popular in higher education. Research on flipped learning, in particular, has shown that the collaborative problem-solving environments are able to better support effective learning than lecture alone. However, the effects of this technique on students' interests and motivations, when implemented in a chemistry course, remain unknown. For this study, students and graduate teaching assistants who participated in a flipped-learning, second-

15   semester general chemistry course were selected to participate in a phenomenographic study that explored their experiences and perceptions of the features of the course. The data were analyzed using open-coding of transcripts and the results were interpreted through the lens of goal orientation theories. It was found that students were primarily motivated by performance-oriented goals and that the structure of the course had a controlling effect on their reasons for pursuing these goals. These

20   factors can lead to maladaptive behaviors and superficial learning. Suggestions are provided that address these factors and provide changes that support autonomy and mastery goals.

GRAPHICAL ABSTRACT

196

INTRODUCTION

Flipped-Learning

Flipped-learning pedagogies have become increasingly popular for chemistry courses in higher education in recent years. With this popularity, has come research on this method's effects on students' learning in chemistry[1-6]. However, the effects of this technique on students' interests and motivations in chemistry remain unknown.

The main difference between a flipped classroom and a traditional classroom is that some form of instruction, such as lectures, are conducted outside of the normal class time, which provides students with the opportunity to go deeper in their learning by engaging in collaborative activities during the normally scheduled in-class session[7]. Studies have repeatedly demonstrated the benefits of flipped learning, with the majority of studies showing positive responses from students experiencing the flipped format[8-10]. While some state that students found the flipped method more preferable, there are other studies that have found that even though most student evaluations of these courses remain stable compared to traditional courses, it is not an instructor-proof method[11,12]. These include cases where the instructor planned poorly, had technological issues, or exhibited negative behavior in the classroom (i.e. underprepared, apathetic, inaccessible, etc.)[12].

Recent studies on flipped learning in general chemistry suggest a need to understand the source of students' perceptions of the course and recommend a qualitative approach for exploring the nuances of these perspectives[13,14]. This type of study has yet to be conducted. As blended learning pedagogies (flipped learning in particular) become more prevalent in the chemistry classroom, it is important to catalog the effects that it can have on a students' interests in learning chemistry.

Motivation

Generally, student attitudes toward chemistry progress from "I can't understand" to "I shall never understand," and finally to "I don't care if I understand."[15] Mahaffy et al. explained that students "find the discipline irrelevant, uninteresting, and indigestible."[16] Research in the role of motivation in education has shown that motivation has an influence over various aspects of how students learn.[17-19]

Environments that provoke the sensations described above risk fostering student behaviors that lead away from learning.[20,21] One theory of motivation, highlights the influence of students' goals and goal orientations on how they engage with course tasks also known as achievement behaviors.

Goal orientations provide a framework for understanding the reasons why people engage in certain tasks.[18] While there are different terms that describing goal orientations in different goal orientation theories, the overarching terms of *mastery* and *performance goals* will be used here.[19] Performance oriented goals focus on demonstrating competence or ability and were originally characterized as a "bad" form of goal orientation.[22] Alternatively, mastery oriented goals focused on learning and mastering skills and was considered a "good" form of goal orientation. Later studies identified that both types of goals could be pursued together and deliver benefits.[23] However, performance-oriented goals specifically, continued to provide mixed effects.[24] In a recent study, self-determination theory was applied to these goal orientations to account for the reasons for goal pursuits,[25] which helped to explain why performance oriented goals can have both negative (maladaptive) and positive (adaptive) effects.

When a performance-oriented goal is pursued for autonomous reasons (e.g., fun, challenges, usefulness, etc.), the educational outcomes are positive, such as increased self-efficacy. However, when performance-oriented goals are pursued for controlling reasons (e.g., rewards, proving oneself, impressing others, etc.), then the educational outcomes are negative, such as avoiding help.[25]

This study seeks to characterize student goals by expanding Sturtevant's research[14] and exploring some of those nuances mentioned by Seery,[15] through a phenomenographic investigation of student and TA perceptions of a flipped, second-semester, general chemistry course.

RESEARCH QUESTIONS

Understanding chemistry students' goals in the context of a flipped-learning environment is necessary in order to better understand why students engage in different achievement behaviors. This understanding may inform future methods that help to support healthy goal orientations in these environments. In a study, with the original objective to understanding how the affordances in a flipped second-semester general chemistry course relate to students' motivation, there emerged some unique results that addressed the following questions:

198

- What are students' goals in a flipped, second-semester general chemistry course?

- How do these goals influence students' motivations in the course?

- What role did the course play in fostering these goals?

METHODS

Framework

The investigators adopted a framework of phenomenography for this study. This framework allows the researcher to position himself so that he can study the ways individuals experience a given phenomenon.[26] The goal of this type of framework is to provide a "description, analysis, and understanding of experiences,"[27] and to characterize the variations in individual accounts of those experiences.[28]

Context

This project examined student and graduate teaching assistant (TA) experiences with a flipped, second-semester general chemistry course for students pursuing a science, technology, engineering, or mathematics major at a large, midwestern, research university. In flipped courses, online learning is combined with in-class work. Specifically, for this course, students experienced flipped learning by watching online lectures outside of class and attending a weekly, two-hour problem-solving session (recitation) where they applied the concepts from the online lectures. This was in addition to the homework assignments and laboratory sessions.

During the first 10 minutes of each recitation, students were given a quiz on the material that was covered during the online lectures. After the quiz, students would work in small groups of no more than 8 to solve these problems. After being given a period of time to complete each problem, a student would be chosen at random from each subsection of 24 students. This student would go up to a small whiteboard on the side of the classroom and provide an explanation of the problem for the rest of their peers in their subsection. The student and their small group would receive a score from their TA based on how well the individual student presented the solution according to a standard rubric provided by the course instructors. There could be up to six subsections in attendance during one recitation.

199

The TAs were assigned to specific subsections of 24 students, where they facilitated collaborative work during the recitation, supervised laboratory classes, and graded student assignments. The TAs would also randomly select and evaluate student presenters.

110   The subjects of this study included the students enrolled in the course and the TAs assigned to the course.

Data Collection & Analysis

Data were collected through focus group discussions, individual interviews, and deidentified course evaluations. A copy of the students' evaluations of the course was provided by one of the instructors.

115   These evaluations are developed, distributed, compiled, and analyzed by the University's Center for Instructional Excellence in order to aid in the improvement of courses. At the end of the semester, students were asked to evaluate the course and the instructor by completing an online survey. The evaluation collected data using a five-point Likert scale, as well as two free response questions. The researcher paid particular attention to the free response questions.

120   Before starting a focus group discussion or individual interview, consent was obtained according to IRB approved protocols. The focus group discussion consisted of six student participants and was video and audio recorded. The discussion began with the prompt, "Please articulate your experiences from the flipped version of *[general chemistry]* this past Fall, compare it with your prior experiences in more traditional courses, and discuss how this influenced your interest in the topic of chemistry," and

125   lasted for 90 minutes. The researcher used probes such as "Could you explain this further?", "How did that make you feel?", and "Does someone else have a different perspective?" to clarify responses to the initial prompt and elicit responses from other participants.

Each of the student participants from the focus group discussion and two additional student participants for a total of 8, volunteered to participate in individual interviews. These interviews

130   followed a four-phased, semi-structured protocol. During the first phase, participants were given a brief overview of the project, asked about their demographics (found int Table 1), and given the opportunity to ask questions of the researcher.

Table 1.Student Participant Demographics.

Participant	Year	Major

200

Harold	Senior	Electrical Engineering
Ashley	Sophomore	Corporate Communication
Megan	Sophomore	Pre-Veterinary Medicine
Chelsii	Sophomore	Nutrition
Isabella	Sophomore	Chemical Engineering
Max	Junior	Material Sciences
Pete	Sophomore	Communications
JoJo	Junior	Psychology

During the second phase, participants were given the opportunity to provide a general reflection on the prompt given during the focus group discussion. During the third phase, participants were given a series of prompts by the researcher and were instructed to reflect on them aloud. The prompts were informed by the basic psychological needs and continuum of motivational regulators found in self-determination theory.[29,30] These questions are listed below:

- What influence did the instructor have on your interest/perception of chemistry?
- Tell me about your thoughts of the instructor.
- Why did you choose to take this course?
- Do you believe that the course content is relevant for you and your career goals?
- Do you believe that you have benefited from taking this course?
- Do you believe that you were given adequate opportunities to show how capable you were with the content?

The fourth phase of the interview consisted of questions developed from preliminary data found in the focus group discussion and one interview with a student who was repeating the course. A series of statements and themes were identified to add as topics that participants were asked to comment on during the remaining individual interviews. The comments fell under the themes found in Table 2. Students who participated in interviews were asked to reflect and comment on these statements.

Table 2. Themes from the Preliminary Analysis of the Focus Group Discussion.

201

Theme	Sample Positive Comment	Sample Negative Comment
Content Relatedness	*having that hands-on approach to it […], that definitely helped me learn the material better.*	*It felt like the course was a second thought.*
Feelings	*I feel like if a lot of classes were set up this way, I would've learned better.*	*I liked the online lectures. It was the in-class recitation that I didn't like.*
Support	*They were moving around the room, but they were always available and very able to explain what I needed to do*	*I'm not saying that we were set up for failure, but we weren't set up for success.*
Presentations	*They added the motivation that we needed to understand the material, because with a presentation, there was always the risk that you would get called up*	*…someone could be great at chemistry, but have horrible presentation skills.*
Individual Effort	*I've never worked so hard in a course as I did in CHM 116.*	*I stopped watching those videos,*

Students who chose to participate in both the focus group discussion and an interview, were also asked to further elaborate on some of the comments that they made during their focus group.

Individual interviews with TAs followed a similar four-phased, semi-structured interview protocol. During the first phase, participants were given a brief overview of the project, were asked about their demographics, and given the opportunity to ask questions of the researcher. During the second phase, participants were given the opportunity to provide a general reflection on a modified version of the focus group discussion prompt given to the student participants, "Please articulate your experiences from the flipped version of [general chemistry] this past Fall and compare it with your prior experiences in more traditional courses that you have TA-ed." During the third phase a base set of interview questions from the student interviews were modified for the TAs as follows:

202

- As a TA, you may have had an opportunity to take a flipped course of your own. If you have, can you comment on any comparisons to this version?
- Tell me about your thoughts of the instructor. (did you feel supported, informed, were you aware of their intention for the course, etc.?)
- Do you believe that the course content is relevant for your students and their career goals?
- Do you believe that your students benefited from taking this course?
- Do you believe that you benefited from teaching this course?
    - Were you able to develop your pedagogical skills?
- Do you feel that you were given adequate opportunities to demonstrate your competence of chemistry?
- Do you believe that you were given adequate opportunities to demonstrate competence as a TA?
- Do you believe that you were able to adequately support your students?
    - How did you support your students?
- Did you feel prepared for the recitations?
    - How did you prepare for the recitations?

Throughout these questions, the TA participants were asked to reflect on their own experiences as well as their perceptions of their students' experiences. The fourth phase of the interview consisted of statements from the preliminary data (identified in Table 1) that TAs were asked to reflect and comment on.

The focus group discussion and individual interviews were transcribed and deidentified along with the free-response answers from the course evaluation. These were then uploaded to NVivo 12 software for data management and analysis.

In order to examine students' goals and the influence of the course on these goals, a set of codes were developed using open-coding[31] and Bryman's four stages of code development.[32] These codes were constantly compared to detect additional themes that emerged throughout the coding process.[31] The same codes were applied to the focus group discussion and the course evaluation. A modified

version of the codes was used in the TA interviews in order to triangulate the data for a final

analysis.[33]

190   In order to determine the reliability of the codes, two additional raters each independently coded a

random transcript. The first rater coded a random transcript from the student interviews using the

original set of codes. The second rater coded a random transcript from the TA interviews using the

modified set of codes. The inter-rater reliabilities of both codebooks were calculated using NVivo. A

kappa of 0.70 was calculated between the researcher and each rater, which suggests a substantial

195   agreement between raters when chance agreements are taken into account.[34,35]

FINDINGS
Student Goals & the Influence of these Goals

Student goals in this flipped-learning general chemistry course appeared to be focused on getting a

good grade and completing the tasks. Most student participants, and even some of the TA

200   participants, identified that the students' primary goals for the course were to maintain their GPA and

get a good grade. Most of the time this involved getting the most points they could with the least effort

necessary.

Megan and the TA, Leah, illustrated this as memorizing the solution for the presentation, rather

than trying to learn the material. Megan explained this saying:

205   *Let's say I was called up* [to present]. *We'd get done working the problem, and then I'd be so*

focused on, this will make sense whenever I come back. […] *They'd want you to go up and*

explain it yourself and you could use the prompt up on the board, but they didn't want you using

the white board in the center, they didn't want you using your notes. So I was so focused on

memorizing what I had already written in the two minutes that we had to write it all down, that I

210   *wouldn't learn. I'd be memorizing and then forget it in the next two minutes. Or if I wasn't called*

on, I'd be like, "Oh, thank god." And then forget what I just memorized. I'd be so focused on

remembering my steps that I took to get to the answer, not understanding why we did those

steps.

Megan was so preoccupied with memorizing what to present, she felt that she was unable to take the

215   time to understand why she was doing those steps in the problems.

204

Leah, the TA, observed this behavior in her students too. She shared, "I seriously can't even count the number of times that I said, 'Quit memorizing it. Like, stop trying to remember what you did last time. Or what you did on the homework or whatever. Like, stop trying to remember what you did and look at this through a new lens. This is a new problem.' "

220 In other cases, the goal of the class was simply to complete it. For students like Ashley and Harold, the class was viewed as another obstacle on their journey to getting a degree. Ashley even said "We're just here to get degrees, not really work for them", and at the end of the course she said, "I looked at my grade once, and I was like, 'Oh, I passed. I'm good.' "

Harold explained "It was just something that I ... Just something I had to get done with. *[...]*
225 I just wanted to be in and out like a normal college student. *[...]* Gen Chem II, it was just one to check off." Both Harold and Ashley were less interested in the content of the course, but more on the completion of the course in order to satisfy their degree requirements. The other student participants reiterated similar perspectives on completing the course.

TAs, like Leah, corroborated the student participants' claims, and made the observation,
230 "All my students were students who do not really care about chemistry, you know? Like, quite frankly, they had to take the class because it's part of their curriculum for whatever it is they're engineering or animal science or whatever."

One student, however, recognized that the things he learned would help him to be a productive member of society later on. Pete expressed that a goal of his was focused on learning the material, so
235 that he could understand it in the future. He commented on the usefulness of the content and shared:

Personally, I think there's definitely ... Not necessarily every, every day applications, but stuff that's going to casually pop up. [...] *Whenever somebody will mention global warming or ocean pollution, it's always going to make me think of chemistry now. That's something that I definitely learned. I can't necessarily apply it, if I was talking to someone*
240 *about it, but it's definitely always going to pop into my head. Like, "Oh. I've learned about this. If I really wanted to, I could give a detailed or an arguable explanation about it."* [...] *And I can understand it more. Like, if on the news, they brought in the expert analyst to talk about something, I can actually understand what he's talking about, to an extent.*

Pete's focus was on how this course could help him to become a more informed citizen who can

245 understand and potentially respond to world events.

The students acknowledged different goals and objectives for the course. These ranged from just another course to check off the list on their way to their degree, to becoming an informed citizen with the ability to engage with science in society. The overall focus of the students, however, was on getting a good grade and maintaining a good GPA. Students who had these goals, focused on completing the

250 activities so that they could receive the associated points, rather than attempting to learn the content.

The data suggests that the student participants sought to perform well in the course in order to get a reward (e.g., points, a passing grade, etc.). This indicates the pursuit of performance-oriented goals for controlling reasons. In the language of self-determination theory, this is autonomy thwarting for the students and discourages internalization of student motivation.

255 Course Influence on Student Goals

The structure of the course and the actions of the TAs and instructors created a culture of performance-oriented goals rather than mastery-oriented goals. The TAs in the course appear to have exacerbated the students' focus on performing a task over learning the concept. Leah, one of the TA participants, described an experience where she briefly observed another TA's section during the

260 laboratory session. She described the atmosphere as one where students felt like they had to "Get in, get *[their]* stuff, get out," and that the TA "*[didn't]* want to see *[the students]* any longer than *[they had]* to." This emphasized the view that it was more important to complete the task in lab, than it was to understand the concepts of the lab.

The TAs' approach to the in-class questions also promoted completing the questions rather than

265 learning the material. Harold described how his TA would just tell him the steps in the problem. While he appreciated their help, he acknowledged that "it wasn't instructional." In this moment, the TA modeled the importance of completing the problem over understanding the concepts that lead to the solution.

The presentations that came after the in-class problems, made students nervous about losing

270 points for deficient performance. This promoted short-term memorization of the in-class problems, as

206

previously described by Megan and Leah, rather than attempting to understand the concepts and how they were being applied.

Each of these accounts are examples of thwarting mastery-oriented goals. The students were not encouraged to take their time in lab, on the in-class questions, nor to prepare for the presentations. The emphasis was on getting each of these tasks done, which disincentivizes mastery-oriented goals.

These accounts also illustrated controlling effects over the students. The student participants did not express desires to do any of these activities out of their own volition, but in a desire to earn the points associated with the task or avoid the shame associated with not doing well, both of which are associated with performance-oriented goals.

The course structure and the behaviors of the course agents were the result of a culture the emphasizes grades over learning. The agents of the course may believe that grades are indicative of what students have learned, when in reality it appears that most grades are a reflection of how well most students memorized the content. While memorization may be a useful skill, it is generally not a learning objective for chemistry course. In order to change this culture of completing tasks over learning concepts, the instructors must create spaces where students do not feel pressed for time or controlled by points. The instructors need to include tasks that are perceived as low risk for students and promote the utility and practicality of the skills associated with those tasks.

IMPLICATIONS

Instructors and TAs can have a profound effect on their students' perceptions and, by extension, goals.[36] The way they demonstrate their views of the students and communicate their goals for students has a far-reaching influence on how students will respond to them and the course.

Ultimately, one of the most important things that instructors and TAs can do, is to begin dismantling the culture of performance-oriented goals.[37] While these goals can promote achievement behaviors in students who feel agency to pursue them, the allocation of points to their performance has a controlling effect on students.[25] By promoting mastery goals, or goals that highlight understanding the material over reiterating the material for a grade, the course may be able to better support achievement behaviors in students.

207

Since student goals in this course appeared to be focused on getting a good grade and completing the tasks, getting point deductions were seen as punishments. The anticipation of getting these

300 deductions stimulated students to focus on getting answers, instead of learning the concepts. While many of the course activities were designed to hold students accountable to their learning, these controlling features effectively undermined the students' "efforts to learn," replacing them with "efforts to complete." Developing new activities that cultivate a culture of learning concepts over getting answers, may help to redirect student goals in a way that fosters achievement behaviors.

305 By structuring the design of the in-class problems in a way that supports students' autonomy, the instructors can help students to experience greater internalized motivation,[20,21] and develop performance oriented goals as a result of their own agency.[25] The students' found that the in-class questions and examples that the instructors were using, although applicable to the real world, had nominal practicality for them as individuals. The student participants specifically expressed that they

310 did not care about the environmental effects, nor did they care about different circumstances that would cause ice to melt. Student participants shared that they wanted information, examples, and skills that would help them in their careers. Even simple items that they could see, made the problems more relevant. The TA, Susie, shared that her students became interested in solving a thermodynamics problem about ice melting when they compared it to the tea that she usually drank

315 during the class. The study would be remiss if it did not acknowledge the difficulty required to adapt questions that are applicable and practical for students. However, simply being aware of this when creating questions and incorporating props, such as Susie's tea, can help students to feel as though they are developing an ability to interact more efficiently with their environment, rather than just dealing with abstract concepts. This may help to promote a focus on the skills that they are developing

320 rather than the problems that they are solving, since it provides a practical analog to something that they may actually encounter.

LIMITATIONS
Due to the relatively small number of student participants (n=8), this should not be interpreted as a representative sample. While the researcher took efforts to demonstrate the credibility of the results

325 through the triangulation of data from sources with different roles in the class (TAs and students) and

208

in different formats (a focus group discussion, interviews, and a course evaluation),[38] there remains a need to conduct a more focused investigation into student goals. This study focused on collecting data related to student experiences in the course, which provided insights into their goals. Since this study was conducted after the students took the course, many of their goals are a result of post hoc

330 reflections, which may not account for the goal orientations they had in the midst of taking the course. A study that can track the evolution and investigate the nuanced complexity of students' goals throughout the duration of the course, may provide details that can illuminate the reasons that students engaged in achievement behaviors and maladaptive behaviors. These results could lead to further interventions and modifications to the course that can address these goals and promote more

335 positive perceptions of the course and greater achievement behavior.

CONCLUSIONS

Students' enrolled in a flipped-learning, second-semester general chemistry course were primarily focused on completing tasks and passing the course with the highest grade they could earn. The role that the course played in fostering these goals may not be surprising, however, these results should

340 underscore the need to further reform general chemistry courses, especially as pedagogies, such as flipped learning, become more popular. If the goals of a general chemistry course, are supposed to include "knowledge of basic chemical concepts, strength in quantitative problem solving, preparation for higher-level course work, maturation of students' knowledge of chemistry, and application of mathematical skills,"[39] then the instructors must redesign the course in such a way that it does not

345 incentivize goals associated with task completion over goals associated with skill acquisition. Until these improvements are carried out, students enrolled in these courses will continue to pursue performance-oriented goals associated with task completion and momentary memorization in order to achieve a grade, while ignoring the development of potentially useful skills and the learning chemistry concepts. Flipped courses that seek to promote these goals, "must be purposefully designed to do

350 so."[40]

AUTHOR INFORMATION
Corresponding Author
*E-mail: roth44@purdue.edu

209

REFERENCES
1. Weaver, G. C.; Sturtevant, H. G. Design, Implementation, and Evaluation of a Flipped Format General Chemistry Course. *J. Chem. Educ.* **2015,** *92,* 1437-1448.
2. Shattuck, J. A Parallel Controlled Study of the Effectiveness of a Partially Flipped Organic Chemistry
365   Course on Student Performance, Perceptions, and Course Completion. *J. Chem. Educ.* **2016,** *93,* 1984-1992.
3. Rau, M. A.; Kennedy, K.; Oxtoby, L.; Bollom, M.; Moore, J. W. Unpacking "Active Learning": A Combination of Flipped Classrooom and Collaboration Support is More Effective but Collaboration Support Alone is Not. *J. Chem. Educ.* **2017,** *94,* 1406-1414.
370   4. Mooring, S. R.; Mitchell, C. E.; Burrows, N. L. Evaluation of a Flipped, Large Enrollment Organic Chemistry Course on Student Attitude and Achievement. *J. Chem. Educ.* **2016,** *93,* 1972-1983.
5. Casselman, M. D.; Atit, K.; Henbest, G.; Guregyan, C.; Mortezaei, K.; Eichler, J. F. Dissecting the Flipped Classroom: Using a Randomized Controlled Trial Experiment to Determine When Student Learning Occurs. *J. Chem. Educ.* **2019,** *97,* 27-35.
375   6. Bokosmaty, R.; Bridgeman, A.; Muir, M. Using a Partial Flipped Learning Learning Model to Teach First Year Undergraduate Chemistry. *J. Chem. Educ.* **2019,** *96,* 629-639.
7. Baker, J. W. The "Classroom Flip": Using Web Course Management Tools to Become the Guide by the Side. In the 11th International Conference on College Teaching and Learning, Jacksonville, FL. 2000.
380   8. Fautch, J. M. The Flipped Classroom For Teaching Organic Chemistry In Small Classes: Is It Effective? *Chem. Educ. Res. Pract.* **2015,** *16*(1), 179– 186.
9. Smith J. D. Student Attitudes Toward Flipping The General Chemistry Classroom. *Chem. Educ. Res. Pract.* **2013,** *14*(4), 607–614.
10. Christiansen M. A. Inverted Teaching: Applying A New Pedagogy To A University Organic Chemistry
385   Class. *J. Chem. Educ.* **2014,** *91*(11), 1845–1850
11. Wieman, C.; Perkins, K.; Gilbert, S. Transforming Science Education At Large Research Universities: A Case Study In Progress. *Change: The Magazine of Higher Learning.* **2010,** *42*(2), 6–14.

210

12. Seidel, S.B.; Tanner, K. D. "What If Students Revolt?"—Considering Student Resistance: Origins, Options, and Opportunities For Investigation. *CBE—Life Sciences Education.* **2013,** *12*(4), 586–595.

13. Seery, M. K. Flipped Learning In Higher Education Chemistry: Emerging Trends and Potential Directions. *Chem. Educ. Res. Pract.* **2015,** *16*(4), 758–768.

14. Sturtevant, H. G. Design, Implementation, and Evaluation of a Hybrid Scale-Up Model For General Chemistry Courses. Ph.D. Dissertation, Purdue University, West Lafayette, IN, 2016

15. Johnstone, A. H. You Can't Get There from Here. *J. Chem. Educ.* **2010,** *87*, 22-29.

16. Mahaffy, P. G.; Martin, B. E.; Kirchhoff, M.; McKenzie, L.; Holme, T.; Versprille, A.; Towns, M. Infusing Sustainability Science Literacy through Chemistry Education: Climate Science as a Rich Context for Learning Chemistry. *ACS Sustainable Chemistry & Engineering.* **2014,** *2,* 2488-2494.

17. Reeve, J. 9: Self-Determination Theory Applied To Educational Settings. In *Handbook Of Self-Determination Research*, E. L. Deci & R. M. Ryan, Eds.; The University of Rochester Press: Rochester, NY, 2002; 183-203.

18. Pintrich P. R. A Motivational Science Perspective On The Role Of Student Motivation In Learning And Teaching Contexts. *Journal of Educational Psychology.* **2003,** *95*(4), 667–686.

19. Schunk, D. H; Meece, J. L.; Pintrich, P. R. *Motivation In Education: Theory, Research, and Applications,* 4th ed.; Pearson: Indianapolis, IN, 2014.

20. Koestner, R.; Losier, G. F. 5: Distinguishing Three Ways of Being Internally Motivated: A Closer Look at Introjection, Identification and Intrinsic Motivation. In *Handbook Of Self-Determination Research*, E. L. Deci & R. M. Ryan, Eds.; The University of Rochester Press: Rochester, NY, 2002; 101-121.

21. Vallerand, R. J.; Ratelle, C. F. 2: Intrinsic and Extrinsic Motivation: A Hierarchical Model. In *Handbook Of Self-Determination Research*; E. L. Deci & R. M. Ryan, Eds.; The University of Rochester Press: Rochester, NY, 2002; 37-63.

22. Dweck C. S. Motivational Processes Affecting Learning. *American Psychologist.* **1986,** *41*(10), 1040–1048.

23. Harackiewicz, J. M.; Barron, K. E.; Elliot, A. J. Rethinking Achievement Goals; When are They Adaptive for College Students and Why? *Educational Psychologist.* **1998,** *33,* 1-21.

24. Midgely, C.; Kaplan, A.; Middleton, M. Performance-Approach Goals: Good for What, For Whom, Under What Circumstances, and at What Cost? *Journal of Educational Psychology.* **2001,** *93,* 77-86.

25. Senko, C.; Tropiano, K. L. Comparing Three Models of Achievement Goals: Goal Orientations, Goal Standards, and Goal Complexes. *Journal of Educational Psychology.* **2016,** *108*(8), 1178-1192.

26. Orgill, M. Phenomenography. In *Theoretical Frameworks For Research In Chemistry/Science Education,* G. M. Bodner, M. Orgill, Eds.; Pearson: Upper Saddle River, NJ, 2007; 127-145.

27. Marton, F. Phenomenography – Describing Conceptions Of The World Around Us. *Instructional Science*, **1981,** *10*(2), 177-200.

28. Trigwell, K. Phenomenography: Variation and Discernment. In the International Symposium Oxford Centre for Staff and Learning Development, Oxford, UK. 2000; 75–85.

211

425   29. Ryan, R. M.; Deci, E. L. 1: Overview Of Self-Determination Theory: An Organismic Dialectical Perspective. In *Handbook Of Self-Determination Research*; E. L. Deci & R. M. Ryan, Eds.; The University of Rochester Press: Rochester, NY, 2002; 3-33.

30. Vansteenkiste, M.; Lens, W.; Deci, E. L. Intrinsic Versus Extrinsic Goal Contents In Self-Determination Theory: Another Look At The Quality Of Academic Motivation. *Educ. Psychol.* 2006**,**
430   *41*(1), 19–31.

31. Saldaña, J. *The Coding Manual For Qualitative Researchers*, 3rd ed.; SAGE: Los Angeles, CA, 2016.

32. Bryman, A. *Social Research Methods,* 3rd ed.; Oxford University Press: Oxford, UK, 2008.

33. Merriam, S. B.; Tisdell, E. J. *Qualitative Research: A Guide to Design and Implementation.* 4th ed.; Jossey-Bass: San Francisco, CA, 2016.

435   34. Landis, J. R.; Koch, G. G. The Measurement Of Observer Agreement For Categorical Data. *International Biometrics Society.* **1977,** *33*(1), 159–174.

35. Viera, A. J.; Garrett, J. M. Understanding Interobserver Agreement: The Kappa Statistic. *Family Medicine*, **2005,** 360–363.

36. Rosenthal, R. The Pygmalion Effect and Its Mediating Mechanisms. In *Improving Academic*
440   *Achievement: Impact of Psychological Factors on Education;* J. Aronson, Ed., Elsevier Science: San Diego, CA, 2002, 25-36.

37. Pope, D.C. *Doing School: How We are Creating a Generation of Stressed Out, Materialistic, and Miseducated Students;* Yale University Press: New Haven, CT, 2001.

38. Denzin, N. K.; Lincoln, Y. S. The Discipline and Practice of Qualitative Research. In *The SAGE*
445   *Handbook of Qualitative Research*, 4; N. K. Denzin, Y. S. Lincoln, Eds.; SAGE: Los Angeles, CA, 2011; 1-19.

39. American Chemical Society, Committee on Education. *ACS Guidelines fo Chemistry in Two-Year College Programs*; Washington, DC, 2015.

40. DeKorver, B. K.; Towns, M. H. General Chemistry Students' Goals For Chemistry Laboratory
450   Coursework. *J. Chem. Educ.* **2015,** *92,* 2031-2037.

212