The Dissertation Committee for Allison Nicole Zengilowski Certifies that this is the approved version of the following Dissertation:

Confusion as an Emotional Metacognitive Process: Students' Voices About Experiencing an Impasse While Learning

Committee:

Diane L. Schallert, Supervisor

Katherine M. Muenks

Veronica X. Yan

Michelle E. Jordan

Confusion as an Emotional Metacognitive Experience: Students' Voices Making Sense of Confusion During Learning

by

Allison Nicole Zengilowski

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Dedication

To the students who struggle and the teachers, whether they be deemed as such by profession or action, who guide them in the pursuit of unending learning.

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Abstract

Confusion as an Emotional Metacognitive Experience: Students' Voices Making Sense of Confusion During Learning

Allison Nicole Zengilowski, PhD

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Supervisor: Diane L. Schallert

Confusion is a frequent and important experience accompanying the learning process, characterized as both affective and cognitive, and especially prevalent during complex learning. Although research has highlighted confusion's affective processes and its connection to learning outcomes, students' lived experiences, what they think about confusion, and what impacts their responses to their experience of confusion have been largely overlooked. Guiding questions for the two studies comprising this project focused on what learners decided to do when confused and what factors played a role in determining the path they took when experiencing confusion. Qualitative methodologies rooted in grounded theory (Corbin & Strauss, 2008) were used in these investigations. Focus group sessions were conducted in Study 1 (n = 27), with students expressing that confusion was a negative experience but useful for learning. Sources of confusion were cognitive (prior knowledge), affective (relational/emotional status), and contextual

(classroom factors), and students recognized their confusion either when initially comprehending or when applying new knowledge. Students relied on themselves and others to resolve confusion, or they ignored it, temporarily or permanently. Factors influencing how students responded to confusion included prior experiences, course goals, and personal/cultural identities. Study 2 examined students' experiences of confusion in online learning environments, incorporating classroom observations and stimulated recall interviews with 19 participants.

Findings from this study were used to create a process model of confusion, illustrating how once students recognize confusion, they choose to address or ignore it. If addressing, learners may move to interim unresolved confusion, and either move to ignore or circle back to addressing the confusion. Addressing confusion leads to one possibility, that the confusion is resolved. Alternatively, if learners ignore confusion, they could do so temporarily, choosing to address it later, or permanently ignore it, resulting in terminal unresolved confusion. Factors impacting students' decision processes before and while they address or ignore confusion were personal, environmental, and resource related. This research develops an understanding of how students conceptualize confusion and the processes they engage in when confused. By centering students' voices and highlighting their perceptions and experiences of confusion, the study provides useful insights for researchers as they bolster the theoretical foundations of how to conceptualize confusion and of the ways it can be resolved. Additionally, the study may be useful for practitioners to help them identify appropriate ways to support learners as they move through confusion.

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14: 18:13:19 Ava T: Interesting. I had a question. What is the difference between attending and listening?

15: 18:13:32 Cassandra: I was also confused about attending

21: 18:14:59 Teacher: Oh good, Cassandra. Let's see if we can make it clearer. So models in qualitative work ...

During the learning process, students are bound to experience confusion in some capacity, as the students revealed in the above dialogue recorded in an online discussion in a graduate course. In this project, I was interested in the role of confusion in knowledge-making and learning, specifically when a person experiences the feeling of confusion. Confusion is an important construct to examine as it is one of the most common emotions students experience when learning with or through another (Lehman et al., 2008), and is prevalent, especially, during complex learning (D'Mello et al., 2014). When resolved successfully, confusion has been shown to be positively correlated to learning outcomes (D'Mello & Graesser, 2012; Lehman et al., 2012b), and can be effective in promoting deep processing, thereby facilitating learning gains (D'Mello et al., 2014). Alternatively, a student who becomes confused and is unable to rectify the feeling may give up, attributing their experience of the emotion to low ability levels (Baker et al., 2010). Such learners may struggle to stay engaged in a course, potentially leading to them dropping out (Yang et al., 2016).

Although I have been referring to confusion primarily as an emotion, it is a particularly interesting emotion as, like other epistemic emotions such as curiosity and interest, it is an emotion coupled with cognition. Confusion is an affective state in that it is a feeling one experiences when faced with an impasse (D'Mello et al., 2010). The cognitive element of the emotion is that it is directly tied to a metacognitive evaluation of whether or not one is in a state of cognitive disequilibrium caused by a block or breakdown in the learning process (D'Mello & Graesser, 2012). Affect and cognition are linked (Baker et al., 2010), with confusion marrying the two by serving as an affective response while a learner is cognitively processing information (Arguel et al., 2017).

Because the kind of confusion in which I am interested is one that arises during the learning process, I will provide a description of how current educational researchers think of learning, before delving more specifically into the literatures I used to ground my project. In the current literature, there does not seem to be a clear consensus on what learning is and of what it consists. In addition, there are many nuances associated with learning, both as a process and a product.

Different theories conceive of learning in distinct ways. For example, a constructivist frame of learning is centered on the idea that an individual is creating meaning in the learning process by connecting new input with existing knowledge (Bodner, 1986; von Glasersfeld, 1990). This meaning can be altered and subject to change at and through different ages, experiences, and relationships that transpire over the course of learning (Jones & Brader-Araje, 2002). A socio-constructivist perspective adds to the constructivist ideas about learning by positing that learning is a social process, and thus, is based in interactions with others, either real and present in the moment or virtual through written or recorded words and signs (Salomon & Perkins, 1998; Staver, 1998).

In current views, learning theorists have included the environment, culture, social setting, and a multitude of other factors that could impact or influence a learner. In addition, they have acknowledged how the learner impacts and changes their context (Alexander et al., 2009). As Alexander and her colleagues (2009) conceived of it,

> Learning is a multidimensional process that results in a relatively enduring change in a person or persons, and consequently how that person or persons will perceive the world and reciprocally respond to its affordances physically, psychologically, and socially. The process of learning has as its foundation the systemic, dynamic, and interactive relation between the nature of the learner and the object of the learning as ecologically situated in a given time and place as well as over time. (p. 186)

Ultimately, learning is an emotionally connected, goal-directed, context-sensitive reliance on existing knowledge in order to make meaning. It is connected to an intention or goal one has in a given situation or environment, where the learner is motivated to continue working to build meaning to satisfy the intention they had in that context. If the learner is unable to satisfy their goals due to an impasse during the process, confusion will occur, and thus, confusion is very much an integral element of learning. And, though some may posit that confusion occurs as a result of being engaged in learning, others believe that confusion is a requisite for deep learning to occur (D'Mello & Graesser, 2012).

WHAT IS CONFUSION?

While learners are processing information that is new to them, they may reach or detect an impasse in their learning, and experience confusion (D'Mello & Graesser, 2012). In the course of experiencing confusion, the learner will likely stop the learning process, reflect upon what has led to feeling confused, and engage in problem solving strategies to ameliorate the confusion (Yang et al., 2016).

Many of the definitions of confusion explore what confusion indicates or how it is experienced. Researchers generally agree that confusion is brought on when learners experience an anomaly, contradiction, or system breakdown, and it occurs in tandem with cognitive disequilibrium, leading learners to experience uncertainty about how to proceed (Craig et al., 2004; Lehman et al., 2012b). Of note, even researchers among the same group have distinguished confusion in different ways, defining it as an "epistemic or a knowledge emotion" (D'Mello et al., 2014, p. 154), or instead of an emotion, a "state" (Lehman et al., 2013, p. 86), only an "epistemic affective state" (D'Mello & Graesser, 2012, p. 146), and hypothesizing it to be the "affective component of cognitive disequilibrium" (Lehman et al., 2012a, p. 186). Although researchers have emphasized the affective component of confusion, learners themselves report that confusion means they "do not understand" something (e.g., topic, concept, material, etc.). Based on 281 survey responses I collected, overwhelmingly, learners align with D'Mello et al.'s (2014) lay definition of confusion being a "noticeable lack of understanding" (p. 158). However, whether to view confusion as an emotion or as a cognitive experience may not need to be debated.

A primary reason for avoiding trying to determine which it is, whether confusion is a mood, an emotion, part of affect, or a component of cognition, may be due to George Mandler's (1975) call, as paraphrased by Graesser and D'Mello (2011), that emotions should not be conceived of in the same way as a scientific construct:

> The words we use to describe emotions are products of folklore, the historical evolution of the language, the social context of interpretation, and other cultural fluctuations that are guided by principles very different from scientific theories of psychological mechanisms. (pp. 11-12)

Rather than ruminating on whether confusion is an emotion *or* a cognition, it is worthwhile to work towards an understanding of how confusion is linked by affect *and* cognition (Graesser & D'Mello, 2011).

To extend further this general conception of confusion and how it is experienced, it is important to consider the difference between *self-realized* and *other-realized* confusion. The former occurs when an individual can determine and is aware of whether or not they are confused. The second type, *other-realized* confusion, arises in cases where the learner did not at first realize they were confused or incorrect about a given topic. For example, when learning arithmetic principles surrounding the use of negative and positive numbers, someone may have the belief that a negative multiplied by a negative number equals a negative number. A peer could explain to them that they are incorrect, and that the product of two negative numbers would result in a positive number. If the first student does not recognize their mistake and cannot rectify how the new information could be correct given their previously held beliefs, they may experience confusion.

These two situations differ in important ways. When a learner realizes, on their own, that they feel confused, they are making a judgement that they do not know something (Clore & Parrott, 1994). In this way, the individual is making an accurate metacognitive judgment based on a feeling in the given learning situation. Conversely, a student who becomes confused only when another points out a flaw in their understanding has experienced a metacognitive failure. They were unaware of their incorrect knowledge and only through someone telling them they are wrong or confused do they recognize there is an issue. This confusion, however, is also a metacognitive signal in and of itself. The feeling alerts the learner that they are not comprehending something, and that they need to adjust the strategies they are using or conceptions they have at the time (Silvia, 2009).

Before continuing to explore the connection between confusion and metacognition, there is one construct that has received some attention in the literature, that is very closely related to confusion, and that needs to be distinguished from it. That construct is *uncertainty*, another cognitive feeling (Clore, 1992) that relies on metacognitive judgements. Uncertainty results from experiencing wonder, doubt, or from being unsure, and is expressed through hedges, such as the use of such words as *maybe*, *sort of*, and *could*, through questions, statements including "I wonder," "I'm not sure," and "I'm curious," among several other ways (Jordan et al., 2014). Uncertainty has many different forms, as individuals can be uncertain about themselves, their knowledge and understanding, the consequences of their actions or future events, etc. (Jordan et al., 2012). Due to how it is manifested, confusion is likely nested within the construct of uncertainty.

When an individual encounters insufficient or incongruent information, confusion may arise (Keltner & Shiota, 2003), leading the person to struggle with determining how to proceed, or alternatively, causing inaction (Rozin & Cohen, 2003). Confusion, then, may elicit an uncertainty about what to do next or how to act, and may require a need for clarification or more information (Craig et al., 2004). Although verbal or written expressions of uncertainty and confusion may appear similar, I believe what makes confusion unique is its association with the recognition that there is some sort of system breakdown or impasse that must be resolved (Lehman et al., 2012b) before one can continue to accrue related knowledge. By contrast, individuals can be uncertain and become curious about concepts that may extend their knowledge, but they can proceed in the learning process without such an abrupt halt as confusion typically triggers. For this project, the focus was on confusion rather than the more general feeling of uncertainty, and in particular, confusion when an individual is learning something academic.

METACOGNITION IN CONFUSION EXPERIENCES

As it has been defined, confusion involves, beyond an affective response, a cognitive recognition that one does not know something about the topic at hand. Such a cognitive judgment has been identified as a component of metacognition (Dunlosky & Metcalfe, 2010), itself a component of the cognitive processes involved in any form of cognition, but especially when learning something new. The construct of metacognition was first introduced by Flavell (1979) to refer to those processes that are triggered when individuals reflect on their own learning, the state of their knowledge, or their recognition of not knowing something. Brown (1980), a student of Flavell's, described metacognition as involving executive processes and skills managing one's cognitive processes, as well as metacognitive knowledge that results from past experiences of engaging one's metacognitive processes.

In his seminal work, Flavell (1979) laid out three primary categories of metacognitive knowledge: *person, task,* and *strategy* that were then refined by Schraw and Moshman (1995) and Pintrich (2002). In this section, I will focus on the most recently updated understanding of metacognitive knowledge, by outlining Pintrich's categories. Pintrich (2002) began with *self-knowledge*, which refers to one's understanding about one's own capabilities and deficits. His *knowledge of cognitive tasks* category involves knowledge about the difficulty levels of varying tasks and how different strategies may be more appropriate than others. Lastly, Pintrich saw *strategic knowledge* as including an understanding of strategies needing to be implemented in a particular learning situation for successful learning, thinking, and problem solving to occur. Taken together, these types of metacognitive knowledge act to support students to become effective learners and evaluators of their learning processes.

How metacognitive knowledge works within the scope of the learning process is still being investigated. Metacognitive knowledge resembles von Glasersfeld's (1990) conception of knowledge in that it is encoded into an individual's long-term knowledge base through the filter of one's experience and perceptions of a learning situation (Wenden, 1998). Although the notion that metacognitive knowledge is a component of an individual's knowledge base is generally agreed upon (see for example Alexander et al., 1991; Flavell, 1979; Wenden, 1998), there is not a consensus on several other facets (Veenman et al., 2006). For example, scholars appear to differ as to whether they find metacognitive knowledge to be explicit and communicable at all times. Whereas Wenden (1998) described this knowledge as something learners are conscious of and can articulate, Schraw and Moshman (1995) reported that explicit descriptions of one's knowledge is a difficult task and may instead remain more implicit. Flavell (1979) took a more neutral approach saying that metacognitive knowledge "may become or give rise to a conscious experience" (p. 908). Although it is unclear currently how explicable metacognitive knowledge must be, it is accepted that when individuals become conscious of their knowledge during the learning process, they can direct their subsequent actions more effectively.

Metacognitive knowledge is a necessary element in the process of monitoring learning (Wenden, 1998). When students do not have metacognitive knowledge regarding their strengths and weaknesses, they are unlikely to determine how to adapt strategy use to new situations or how to regulate learning within these environments (Pintrich, 2002; Pressley et al., 1989). With the aid of metacognitive awareness, learners can make informed decisions about how to proceed in a given task or learning environment through an understanding of themselves, their tasks, and the strategies they can use (Cotterall & Murray, 2009). This monitoring process is subject to feedback, and when students are

taking an active role in evaluating events, this metacognitive knowledge allows learners to evaluate when they should maintain, revise, or reject previously made decisions (Wenden, 1998).

In an early study on metacognition, Schraw (1994) found that those who were high monitors of their comprehension used the information acquired during the reading and testing phases better than their low monitor counterparts. In part, this was exemplified through better performance by the high monitors than low monitors. In addition, the high monitors were more confident and accurate in judging their performance than the low monitors. These findings may indicate that having a high level of awareness about one's cognition can aid in reaching high levels of regulatory competence.

Bjork and colleagues (2013) reported, similarly, that to be a successful learner, one needs to be able to monitor and control their learning process. Individuals must continuously make accurate assessments about their state of knowledge and, from this, make decisions about what to study and how to study. If completed in tandem and repeatedly over the course of the learning process, an individual will go on to perform well on assessments and to become a sophisticated learner, more generally. Although metacognition can be effortful to monitor and react to, it is an integral part of meaningful and deep learning.

One area where metacognitive knowledge may play a worthwhile role is in the determination and experience of confusion. This knowledge would be most salient in instances where learners interact with information, such as reading or during a lecture. If a student believes they have a grasp of a concept and a general facility with the information, they will be unlikely to review the material in depth (Pintrich, 2002). If in actuality the individual does not understand the information, this metacognitive failure can be deleterious, leading to an inability to determine where the breakdown in the learning

process occurred (Goos, 2002). Thus, metacognitive awareness may follow, linearly, along two tiers during the learning process: (1) distinguishing between understanding and not understanding; (2) distinguishing between accurate/real understanding and inaccurate/illusory understanding. In this conception, learners will first recognize that certain information results in feelings of confusion or uncertainty, whereas other material does not engender these same feelings, resulting in a more concrete sense of what actions should be taken next. When considering confusion as a meta-judgment, learners may make a determination as to whether or not they are confused at the first tier, but only once they are successful in doing so can they move on to greater levels of sophistication in their metacognitive control of their learning.

A problem with metacognitive knowledge, especially in regards to making important decisions about the learning process, is that it "can be inaccurate, can fail to be activated when needed, can fail to have much or any influence when activated, and can fail to have a beneficial or adaptive effect when influential" (Flavell, 1979, p. 908). Taking this into account, it appears as though teaching and learning about metacognitive knowledge, embedding it within lessons, and explicitly teaching about it could facilitate its development, which is important given the strong reported influence on student learning (Pintrich, 2002).

EMOTIONS IN CONFUSION EXPERIENCES

Although long ignored in the learning literature, the last 15 years have seen a surge of interest in the role that emotions can play in the motivational and cognitive processes involved during learning (Baker et al., 2010; Lehman et al., 2008, 2012b; Pekrun et al., 2002). As emotions have been shown to impact motivation, performance, and productivity (Pekrun et al., 2009), a specific type of emotion closely tied to learning are achievement

emotions. These are connected to and induced by activities (such as studying) or outcomes (success or failure) when academic achievement is a goal (Pekrun & Stephens, 2010). Whereas the activities and outcomes can influence the emotions a learner may experience, the learner's emotions, similarly, have a reciprocal effect on the activities and outcomes in which they engage (Pekrun & Perry, 2015). What types of emotions an individual experiences and how they respond to them can determine how successful they will be in the learning process and in achieving their goals.

If confusion is a positive emotion, or perceived as such by a student, it could lead them to engage thoughtfully and with deep learning strategies to work through the impasse. Conversely, if confusion is a negative emotion, or perceived as such, it could lead students to employ the protective behavior of tuning out, during which they disengage from the task at hand and do not resolve the emotion nor the difficulty (Do & Schallert, 2004). Given this information, it would be important to determine how learners are interpreting the emotion of confusion and what they choose to do when experiencing it.

General Assessment of the Literature on Confusion

Given the limits of the current literature, in this section I am going to synthesize the state of research on confusion and how I planned to contribute to the field through my research. The literature surrounding confusion is somewhat sparse and dominated by one research group in particular. Primarily, previous studies have considered the affective or emotional side of confusion.

The most relevant piece of work is D'Mello and Graesser's (2012) paper in which they examined how confusion preceded or was a result of other emotions including flow, frustration, and boredom. In this study, participants interacted with an AutoTutor as they engaged in a dialogue with the tool about topics related to computer literacy. The

AutoTutor prompted the learner with various questions or problems that the learner then answered. After the session, the participants went back to review a synchronized video of their screen recording and of their faces so they could report on their affect at various points in the experimental procedure. They found that participants transitioned from flow to confusion, confusion to flow, and confusion to frustration. As such, the authors proposed a model that would indicate the systematic way in which learners move between different affective states. Related to confusion, the primary difference between whether a learner returned to a state of flow or ended in a state of frustration was if the impasse that led to the disequilibrium, causing confusion, was resolved or not. If an individual could resolve the impasse, they would re-engage in a state of flow; otherwise, the learner would move from their confused state to a feeling of frustration when unable to rectify the impasse.

As exemplified in the D'Mello and Graesser (2012) paper, the majority of the studies examining confusion are focused on what causes the emotion and what are its learning consequences. There is an assumption, in this literature, that we understand fully how confusion is experienced and its impact on students' overall learning experiences. I set out to design and conduct research to explore additional complexities to confusion, the factors and constructs that may impact the experience, and the results of confusion. Most importantly, I aimed to help address the dearth of inquiry about how learners conceive of and decide to react to the feeling of confusion in authentic settings.

STUDY RATIONALE AND RESEARCH QUESTIONS

Confusion leads students to an important crossroads in their learning. When they become stuck at an impasse, they must determine what is the best, or perhaps most desirable, course of action given their goals. The general consensus from the literature appears to be that working to resolve one's confusion leads to beneficial learning gains, no

matter whether this resolution is accomplished through the use of active strategies, like desirable difficulties, or with the aid of scaffolding by a more knowledgeable other. However, students likely do not rely on the empirical literature to make decisions about how to proceed when confused.

Although researchers have explored the immediate predecessors to confusion (i.e., anomalies, contradictions, general cognitive disequilibrium), general actions learners can take when experiencing confusion, and learning outcomes associated with these actions, the literature was nevertheless sparse. In order to identify the appropriate scaffolds for students so that they may find beneficial ways to embrace and move through their confusion, it seemed important first to determine what actions they were taking when they experienced confusion while learning academic content, and why they had taken those particular actions. Therefore, my research questions were as follows:

1. What do learners decide to do when they are confused?
2. What factors (e.g., prior preparation, learning environment, social factors, metacognitive beliefs, self-efficacy) play a role in determining what path students take when feeling confused?

In the next chapter, I provide a review of the literatures on metacognition and emotions in the learning process, ending with a synthesis of these areas and their relations to confusion. In Chapter 3, I include a description of my methodological approaches to these inquiries before explaining the setting, participants, and procedure of Study 1. I conclude this chapter with a discussion of the data analysis processes and ways in which I ensured trustworthiness of the data and subsequent analyses. I present the findings from Study 1's focus groups in Chapter 4. In Chapter 5, I discuss the need for Study 2 and what I investigated as part of it. After a brief overview of the pilot study, I explain the setting, participants, procedure, data analysis and trustworthiness of Study 2. Chapter 6 consists of

the findings from the second study including a description of the proposed process model of confusion. Finally, in Chapter 7, I synthesize elements of the findings from the two studies, integrating this with considerations of how the studies support or challenge the existing literature. I conclude the chapter with a discussion of the theoretical and practical implications of these studies, their limitations, and potential future directions.

Chapter 2: Literature Review

This chapter provides a synthesis of relevant theoretical and empirical literature as it relates to the scope of my studies. I begin with a review of metacognition, including explanations of feelings and judgments of learning in addition to an exploration of the topic of desirable difficulties. Following this, I move to consider emotions in the learning process, specifically focusing on achievement emotions. I end the chapter with a review of the literature on how metacognition and emotion play a role in the antecedents to, concomitants of, and consequences of confusion.

METACOGNITION

Following what had been the dominance of behaviorist views and approaches to investigating questions about learning, many psychologists in the 1950s through the late 1960s began to note the fact that such perspective lacked the ability to explain learning behaviors fully. This shift marked the beginning of the Cognitive Renaissance, about the same time that the construct of metacognition entered the literature, a construct focusing on a person's thoughts about their own thoughts and cognitions (Dunlosky & Metcalfe, 2009). Since its introduction into the literature, metacognition has been closely tied to learning processes (Livingston, 2003), making it an important construct to examine when considering students' experiences of learning in academic contexts.

Flavell (1979) is largely credited with coining the term *metacognition*. He posited there to be two primary forms of metacognition: knowledge of one's cognition and experiences of regulating one's cognitions. The first regards knowledge about cognitive processes, which could, in turn, be used to regulate these processes, the second form of metacognition (Livingston, 2003). In his work, Flavell (1979) introduced three categories of metacognitive knowledge: person, task, and strategy. For person, the category broadly

considers what people believe about themselves and others in terms of being cognitive processors. This could include beliefs about intra- and interindividual capabilities and differences in addition to general cognitive principles. The second category, regarding the task, incorporates a general understanding of how differences among tasks require a variety of approaches in order to be managed successfully. Moreover, the category is meant to encapsulate how an individual understands how successful they may be in accomplishing a task or goal. Finally, the third category is strategy. The metacognitive knowledge involved here is focused on determining what strategies are likely to be effective when utilized in different situations and for varying tasks, and on deploying these strategies.

Flavell (1979) considered metacognitive experiences as an important factor in understanding metacognition more generally. These experiences accompanying some sort of intellectual work can be cognitive or affective in nature. For example, while listening to a lecture, one becomes aware that one does not understand what the professor has said. Depending on the goal a learner has for themselves, their metacognitive experience can lead them to consider different strategies to employ in pursuit of their goal (Flavell, 1979; Livingston, 2003). For example, during a lecture, a student may have a goal of understanding a foundational concept. If they find they are unable to do so, they may decide to ask the professor a question, read relevant parts of the textbook, re-watch the lecture, or switch to other actions or concerns.

This example and the category of *strategy* encapsulate what more recent researchers have separated into two distinctions: metacognitive monitoring and metacognitive control. Monitoring focuses on the individual's judgment of their progress or the state of a cognitive activity: Am I accurate in my understanding of a concept? Metacognitive control, on the other hand, pertains to the regulation of an individual's actions (Dunlosky & Metcalfe, 2009). Upon recognizing they do not understand the concept, does the learner stop

studying? Do they engage in a new strategy? What strategy do they choose? Metacognition, no matter the stage, unfortunately, can be inaccurate. Learners have the possibility of overestimating or underestimating their competences or the task complexity, indicating a lapse with metacognitive knowledge (Veenman, 2015). They may be inaccurate in judging whether or not they understand something, a problem with metacognitive monitoring (Nelson & Fyfe, 2019). In addition, their metacognitive control may be poor, as in instances where they make a poor choice for what strategy or approach to use to ameliorate their issue, or if they lack the motivation or capability to do so (Dunlosky & Metcalfe, 2009). A breakdown at any step could lead to undesired effects in the learning process.

Metacognitive Feelings and Judgments of Learning

One substantial area of research on metacognition has been dedicated to learners' feelings and judgments about learning. Nelson and Narens (1990) put forth three primary categories in this area: ease of learning (EOL), judgment of learning (JOL), and feeling of knowing (FOK).

Ease of Learning

The first, EOL judgments, occur before the learning process has begun (Nelson & Narens, 1994), or early on, and describe the perception an individual has about how difficult it will be to learn new material (Jemstedt et al., 2017). These judgments are important as they determine one's studying behaviors and guide subsequent learning (Nelson & Narens, 1990). Findings about EOLs, what influences them, and their impact on learning and performance have been mixed. Studies have reported that high levels of prior knowledge make EOLs more accurate, leading to enhanced performance on posttests (Mihalca & Mengelkamp, 2020) and that material cues can increase the accuracy of EOLs

(Jemstedt et al., 2017). Other studies have found that EOLs do not have a significant impact on allocation of time or strategy use (Son & Metcalfe, 2000), and that they poorly relate to performance on a recall test (Leonesio & Nelson, 1990).

In the context of confusion, EOL judgments could prime learners for recognition or could result in a negative response. If a student believed that they were going to have difficulties understanding content from a given class session, during learning, they may be looking out for sources of or times when they were confused. Alternatively, if the student predicted the lesson should be easy, only finding it to be challenging once they were immersed, they may be more likely to exhibit feelings of shame or hopelessness, potentially inhibiting their desire to address and resolve confusions.

Judgments of Learning

When in the process of learning, individuals make judgements as to how well their learning is progressing, or what are called JOLs. These judgments are used to predict future performance (Nelson & Narens, 1990). Learners use cues based on their beliefs (e.g., "I learn by watching videos") or based on their experiences (e.g., familiarity of answers, response time, response accuracy) (Bjork et al., 2013). Most researchers asked participants to report their JOLs as a probability or percentage of likelihood that they will remember the given item successfully. Accuracy is then reported through absolute means, how correlated are the judgments and actual performance, or through relative standards. Relative accuracy considers the correlation between JOLs and memory performance. Greater accuracy can come in two forms: (a) how many high JOLs correspond to actual remembrance; (b) how many low JOLs correctly predict a low likelihood of remembrance (Rhodes, 2016). When learners make inaccurate JOLs during the learning or studying process, they will misdirect how they use their time. For instance, if a learner makes an

inaccurate JOL that they do understand something that, in reality, they do not, they will allocate time to other concepts for which they believe they do not yet have a strong grasp, ignoring the concepts that do require additional revision to be understood (McDaniel & Butler, 2010). In the context of confusion, an inaccurate JOL could mask confusion when a learner decides they understand content, moving on in the learning process, when in reality, they are confused.

One of the most notable findings related to JOLs is that students' judgments do not consider the difference between effective and ineffective encoding strategies. For example, there is clear evidence for the positive impact of spaced practice (Ebbinghaus, 1885/1964; e.g., Bjork & Bjork, 1992; for a review, see Cepeda et al., 2006) and testing (e.g., Carpenter et al., 2008; Roediger & Karpicke, 2006; Toppino & Cohen, 2009; for a review, see Roediger & Butler, 2011) on later memory and retention. Unfortunately, participants do not appear to give adequate weight to the power of spaced testing on later recall (e.g., Logan et al., 2012). Nor do they provide higher JOLs for tested over restudied information (e.g., Kornell & Rhodes, 2013).

Although the research may seem bleak, learners are not incapable of eliciting some beneficial strategies from their JOLs. When reporting on JOLs, learners have shown a preference for effective strategies including generation (Castel et al., 2013) and interactive imagery (Dunlosky & Nelson, 1994). JOLs are also sensitive to prior learning experiences, indicating that learners have the capability of revising their understandings of factors that influence memory (Rhodes, 2016). When students make a judgment that they are confused, it is possible that they can use these JOLs to determine the most effective strategies to employ in service of resolution.

Feeling of Knowing

Feeling of knowing judgments focus on instances when learners cannot remember an item but consider the likelihood that they will remember it later (Koriat, 1993; Nelson & Narens, 1990). These judgments may be based on a feeling of the item being on the "tip of the tongue," which could be a result of a partial retrieval of information related to the item (Brown & McNeill, 1966; Nelson & Narens, 1990). Alternatively, FOKs can be based on the familiarity or recognizability of the cue being used to prompt retrieval of a specific item, with familiar cues leading to higher FOKs (Metcalfe et al., 1993). This can be measured after a recall test when participants are informed about items they answered incorrectly. Then, they self-report through ranking or rating which of these items they may know (Pintrich et al., 2000).

Participants' FOKs turn into judgments about how to proceed with a given recall task. This may include determining when to stop searching for the item in memory (e.g., Singer & Tiede, 2008) or deciding if, when preparing for future retention tests, restudying a specific item is worth the time and energy (Hanczakowski et al., 2014). Due to the metacognitive judgment a learner makes when they recognize that they are confused, learners may have more accurate FOKs about an item than if they did not experience confusion.

Familiarity may go beyond cues related to the item. Hanczakowski and colleagues (2017) found that context familiarity impacts FOKs, with participants indicating higher FOKs when the context was familiar rather than novel. Their results showed that participants offered higher FOKs when recalling an item in the same context as they had encoded it, rather than a familiar, but different context as when encoding took place. These findings indicate that learners use a variety of cues during retrieval to determine if items they need to recall are stored in their memory.

Desirable Difficulties

When considering learners' thoughts about learning, it is possible for them to be incorrect in their judgments. Even when learners judge a task or strategy to be difficult, they are still learning. In fact, difficulties in the learning process can lead to better long-term retention compared with learning strategies that feel easier due to superficial processing (Schmidt & Bjork, 2002) and may promote more accurate metacognitive monitoring (Rivers, 2020). For example, Carpenter et al. (2013) investigated students' perceptions of and actual learning from a lecture that was fluent compared to another that was disfluent. Participants who viewed the fluent lecture perceived themselves to have learned the content better, despite there being no significant difference in actual performance on a posttest compared to those in the disfluent group. As this study indicates, what learners may perceive as easy to learn may not result in it being easy to remember. Difficulties in the learning process may assist with metacognitive accuracy, specifically when they facilitate monitoring of ongoing learning (Rivers, 2020). These difficulties can alert students that they need to engage further with certain concepts in order to promote long-term learning.

The concept of *desirable difficulties* (Bjork, 1994) considers how testing and varying types and spacing of practice and interleaving result in the appearance of a slow process of learning. These practices often lead to long-term retention and transfer (Bjork, 2018). Through these techniques, learners can create a greater range of associated contextual cues for future retrieval. Also, they may forget material but then engage in retrieval practice and/or active strategies, fostering future retrieval (Bjork & Bjork, 2019).

However, this process may result in negative consequences if the difficulties associated with the learning process are not properly addressed. When learners do not have the knowledge, skills, or strategies to respond to a difficulty, it will become undesirable

(Bjork & Bjork, 2014). Another case is when learners do engage in a productive, active strategy, but are unable to be successful. For example, when working with flashcards, learners are engaging in the process of generating the to-be-remembered item. If the generation succeeds, that bolsters future learning. If it does not, the benefits disappear (Bjork & Bjork, 2019). What has been noted in this process, however, is that attempting active strategies and failing can enhance memory and learning when feedback (the correct answer) is provided to the learner (Kornell et al., 2009).

To elucidate this point that the appropriate "toolset" must be available, a difficulty that is desirable for one learner may be undesirable for another. McDaniel and his colleagues (2002) conducted a study investigating how increased text difficulty would impact high- and low-ability readers' comprehension and later recall of a passage. In the control condition, participants read an intact version of the passage. Text difficulty was manipulated in experimental groups by having students (a) generate the text using sentences presented on individual pieces of paper in a random order, or (b) fill in missing letters that were deleted from the passage as they read. These generative processes, in theory, are considered desirable difficulties and could lead to effective retention.

For both experimental groups, the high ability group recalled significantly more of the passage than the low-ability group. Both generative processes resulted in higher proportions of recall above the control condition for the high-ability participants. For low-ability participants, the sentence scrambling task led to a higher proportion of text recall than the control, but the letter deletion condition led to a significantly lower proportion of recall than the read-only condition. This indicates that there are certain comprehension demands for which these low-ability participants had selective deficiencies. The letter generation task, though typically presenting a desirable difficulty, hindered comprehension and learning, in this case. However, certain processes may enhance low-ability

participants' retention by scaffolding them to engage in productive processes, such as organizational and structural ones that they do not spontaneously accomplish, as do high-ability readers. Thus, when evaluating difficulties and whether or not they will be desirable, it is necessary to consider the specific difficulty, the materials to which such difficulty is applied, and learner characteristics (McDaniel & Butler, 2010).

Measurement

A foundational issue associated with measuring metacognition and metacognitive strategy use involves using self-reports or behavioral, in-the-moment techniques. Self-reports that ask students to reconstruct memories of task engagement or processes likely will suffer from validity problems, as participants in such assessments must rely on a reconstruction of a memory, which can result in memory failures or distortions (Veenman, 2011a, 2011b).

Methods for measuring and capturing metacognitive strategies in real-time show higher construct validity than self-reports (Veenman, 2015). Specifically in reading tasks, for example, researchers may employ one of several methodologies, potentially triangulating them. Think-aloud protocols are one tactic, where learners report on their behaviors as they are engaging in a reading task (e.g., Pressley & Afflerbach, 1995). Engaging in a think-aloud procedure is not inert to participants, and may change what they would otherwise do, altering their naturalistic processing or overall comprehension (Fox et al., 2011). However, some previous studies that have noted that think-alouds do not have an undue influence on text comprehension (e.g., Afflerbach & Cho, 2009), and that triangulation is an effective way to determine if participants have changed their processes as a result of the method (e.g., Kendeou et al., 2019). A less intrusive tactic, eye-movement tracking, can show researchers how students are moving through a given reading,

highlighting potential areas where they are struggling and may be making metacognitive judgments. Alternatively, participants may engage in an environment that logs the activities one completes. Again, in reading, this could involve tools that allow for highlighting text, commenting, making notes, or other behaviors (Veenman, 2015).

A limitation with measures of metacognitive knowledge is that they are designed with a specific population and domain in mind (Pintrich et al., 2000). For example, the Index of Reading Awareness (IRA) was designed for elementary students to capture their metacognitive knowledge for reading comprehension (Jacobs & Paris, 1987; Paris & Myers, 1981). The Metacognitive Assessment Inventory (MAI) assesses general metacognitive knowledge and regulation for college students (Schraw & Dennison, 1994). Neither was developed on diverse populations in terms of race, ethnicity, or ability (Pintrich et al., 2000).

In sum, students' metacognitions play a central role in their learning processes, especially when they are confused. Having the ability to monitor learning, making accurate judgments of what is known and not known, can induce productive learning processes post recognition of confusion. With the potential to facilitate implementation or interaction with appropriate desirable difficulties, students who experience confusion may experience deeper and more long-term learning outcomes than those who are not confused, or who do not become confused during their learning process.

EMOTIONS IN THE LEARNING PROCESS

Learning is an emotional process with unique signatures for each individual. When considering them from a socio-constructivist perspective, emotions can be defined as:

> Socially constructed, personally enacted ways of being that emerge from conscious and/or unconscious judgments regarding perceived successes at

> attaining goals or maintaining standards or beliefs during transactions as part of social-historical contexts. (Schutz et al., 2006, p. 344)

Two types of emotions are relevant when considering their role in the learning process and with confusion: achievement and epistemic emotions.

Achievement Emotions

Pekrun's (2006) control-value theory of achievement emotions posited that emotions have a valence (positive or negative), a type of activation (activating or deactivating), a focus (process or outcome), a time orientation (prospective and future-oriented or retrospective and past-oriented), and are reciprocally impacted by the learners' environments and their appraisals. Elements of the environment that could influence achievement emotions are autonomy-supportive versus controlling (e.g., Patall et al., 2018) and belonging or relatedness (e.g., Wilson et al., 2015).

In Pekrun's theory, students' appraisals are separated into two categories, either being control- or value-related (Pekrun et al., 2002). When learners feel they have the ability to master material, they are deemed to have high control in their academic experience. With confusion, for example, if a student is unable to identify a path toward resolution, they may feel that they have low control (Peterson & Cohen, 2019). Value-related appraisals can take on a variety of forms, but two important ones in the context of confusion are self-efficacy and interest. Self-efficacy refers to beliefs about one's academic abilities and one's judgements of confidence to perform certain tasks (Parker et al., 2018; Ryan & Shin, 2011). Interest may be tied to intrinsic motivation (Ryan & Deci, 2016) or how much a student intrinsically values the material with which they are interacting (Pekrun et al., 2002). If a student has high self-efficacy or interest in a domain in which they are confused, they may find themselves experiencing positive achievement emotions

like enjoyment in trying to solve the issue or pride when their efforts result in resolution. Conversely, low self-efficacy and interest could result in learners finding themselves anxious or ashamed about confusion, and a sense of hopelessness about whether they have the ability to resolve the impasse. To delineate further how achievement emotions interact with confusion, in the next paragraph, I will discuss their differences in valence and activation.

Activating positive emotions (joy, excitement) are seen to be those that encourage students to engage in deep and flexible learning strategies, whereas activating negative ones (anger, frustration) lead to shallow and rigid processing of information (Pekrun & Perry, 2015). Deactivating emotions, whether of positive (such as relief) or negative (such as boredom) valence, usually signal the end of a learning cycle. When classifying confusion as an emotion, most researchers have labeled it as an epistemic rather than an achievement emotion (e.g., Vogl et al., 2020). However, it is likely that confusion is associated with positive or negative, or activating or deactivating emotions. In the rest of this section, I will focus on parsing out how positive and negative emotions play a role in the learning process and how these two categories of emotion relate to confusion.

The connection between achievement goals and the performance that will lead one to reach these goals is mediated by emotions. If a learner experiences a positive emotion, they likely will be motivated to work through a given task. However, if the individual experiences a negative affective state, they may avoid engaging with the task at hand (Pekrun et al., 2009). This theory was shown to play out in the lives of students through a study conducted by Do and Schallert (2004). Through classroom observation sessions, stimulated recall interviews, and self-reported surveys, the authors were able to track the role that emotions played in how students engaged in in-class, face-to-face discussions. They found students reacted and interacted differently with the ongoing class discussion

when experiencing positive versus negative emotions. When a learner felt a positive affect, they were attentive to the discussion and would transition between deep listening and talking. Negative emotions, however, influenced students to engage in a behavior of *tuning out*, where they would disengage from the conversation for a brief time. When tuned out from the discussion, these learners were unable to learn from their peers. The action of tuning out did lead to at least one benefit: students were able to take time to halt their negative emotions and reset their emotional energies, leading them to feel better than they had when initially prompted to tune out, and to return to the discussion.

This study has important implications for learners experiencing confusion. When confusion is considered to be positive or results in positive emotions, learners will remain present in working to resolve the confusion. However, when confusion is a negative experience with negative emotions associated, students may become frustrated and disengage. This act of disengaging in the moment may be a meaningful protective strategy, however, as learners consider how to maintain composure in the face of confusion and then engage with active strategies to resolve it at a later time.

Epistemic Emotions

Epistemic emotions are another type of emotion that may be relevant and need to be explored as to how they play a role in the process of learning. Epistemic emotions are conceived to be emotions that come about as a result of appraising how well new information aligns or does not align with existing beliefs or knowledge structures (Muis et al., 2018). These emotions can include surprise, curiosity, and confusion (Vogl et al., 2020) and are posited to be influential in learning and cognitive performance (Pekrun & Stephens, 2012) as they facilitate critical reflection and inquiry (e.g., Morton, 2010). Epistemic emotions are likely to be related to achievement emotions, specifically when cognitive

incongruity or contradictions plays a role, as in the case of confusion (D'Mello & Graesser, 2012). As Vogl and their colleagues (2020) described, "in addition to feeling surprised, curious, or confused, individuals whose knowledge is challenged may also feel ashamed when something they thought to know turns out to be incorrect, or proud if their knowledge is confirmed" (p. 626). Thus, how confusion is interpreted or addressed could influence subsequent emotions a learner experiences.

When considering how emotions are related to metacognitive judgments, Vogl et al. (2020) examined how errors with differing confidence levels (high or low) led to the experience of specific epistemic emotions. Findings showed that high-confidence errors, similar to inaccurate JOLs, led to surprise, curiosity, and confusion. These results support the notion that metacognitive processes and judgments can be an important precursor to epistemic emotions.

Vogl et al. (2020) also explored how epistemic emotions impacted participants' explorations after they were told their given answer was correct or incorrect. They found that experiencing confusion after answering a question incorrectly did predict exploration, but the effects were weak. The authors posited that this weak effect could be due to the negative activating achievement emotions confusion elicits, which likely impacts students' motivation in this way, specifically when the learner does not expect to resolve their confusion successfully. However, if students do believe they have the capability, strategies, or resources necessary to address their confusion, this experience may lead to heightened motivation to engage in seeking confusion resolution.

A Synthesis of the Literatures on Confusion, Emotions, and Metacognition: Confusion as an Affective Meta-Judgment

My focus, ultimately, for my research was on confusion as a metacognitive, emotional experience, and thus, I saw these three areas, confusion, metacognition, and emotions, as related to one another. In this section, I review research that has shown a connection between confusion and either metacognition or emotions, or both. Due to the fact that I consider confusion to be part of a process, I will be organizing these studies in terms of those that look at what leads to confusion, ones that discuss what accompanies feelings of confusion, and those that consider what ensues from confusion.

Antecedents to Confusion

Confusion frequently results from an impasse reached during the learning process. This barrier is caused, typically, by a discrepancy or mismatch between prior knowledge and the incoming information (D'Mello et al., 2010, 2014). When a learner cannot integrate the content into their existing model of the world, or when inconsistencies cause the learning process to be halted, an individual will enter into a state of cognitive disequilibrium. Learners, then, are likely to experience confusion, an emotion that arises out of a state of disequilibrium (D'Mello & Graesser, 2012; D'Mello et al., 2014). Poor performance may be another antecedent for confusion, for this could be due to an impasse that is blocking a learning goal of understanding difficult topics or solving a complicated problem (D'Mello et al., 2010). To resolve confusion, individuals must engage in effortful, high-level metacognitive strategies that target the root of the impasse (D'Mello & Graesser, 2012; Ku & Ho, 2010).

To capture a sense of the empirical evidence that underlies these claims, I want to describe in more detail one of the central studies from the research program of D'Mello, Graesser, and their colleagues. These are the researchers who have done the most important

and substantial work on confusion. In D'Mello and colleagues' (2010) paper, the authors examined the affective states participants experienced when engaged in effortful problem solving.

The study consisted of learners solving analytical reasoning problems while being videotaped. After reading the problem scenario, participants answered the subsequent multiple-choice question, and after finalizing their choice, were given feedback as to whether they were correct or incorrect. The feedback, however, was manipulated wherein incorrect feedback (i.e., negative feedback for a correct answer; positive feedback for an incorrect answer) was randomly given to 25% of the responses. After completing the problem-solving portion of the study, participants took part in a retrospective affect judgment protocol where they would view videos of their screen and their faces simultaneously, and would make judgments of their emotions at predetermined points in the session (e.g., problem onset, after feedback).

The authors found that confusion happened at levels higher than chance, indicating that it is a routine emotion that accompanies effortful problem solving. Confusion was observed most frequently when presented by a new problem and during the problem-solving process. With feedback, confusion was more likely to occur when participants were provided negative feedback to an answer they believed was correct than when they were given positive feedback. Given these results, it appears that two antecedents to confusion could be the presentation of a new problem and unexpected negative feedback.

Concomitants of Confusion

When an individual becomes confused, they have several courses of action they may decide to take. If a learner chooses to remain confused without seeking help from other sources or people, or if their resolution fails, they are likely to have poor learning

outcomes, disengage, and could drop out of a given learning environment (D'Mello et al., 2014; Yang et al., 2016). If they attempt to continue learning, it is possible that the unresolved confusion will cause further impasses in building knowledge.

Another route one could opt for is to voice one's confusion and await help from another individual to resolve it. In a study by Rozin and Cohen (2003), participants' facial expressions were observed when they were confused. The authors posited that the expression of confusion may, purposefully, encourage social interaction, acting as an adaptive marker so as to receive support and help the person out of the confusion. Students are more likely to persist in their learning environment when helped out of their confusion than if they are left to fester with their emotion (Yang et al., 2016). As with many situations where another individual is assisting during the learning process, confusion must be appropriately scaffolded for that student's needs in order to mediate and affect learning in a beneficial way (Lehman et al., 2012b). The last possibility of an option a student can take, when they are aware they are confused, is to work to resolve the impasse on their own.

Upon becoming confused, an individual will likely stop and reflect. If choosing to address the impasse, learners will need to engage in active and effortful cognitive activities (D'Mello et al., 2010, 2014; Lehman et al., 2012b; Yang et al., 2016). Activities to resolve confusion such as revising existing mental models and engaging in problem solving are deemed to be desirable difficulties. These strategies may require a great deal of effort and can slow learning progress, but are likely to lead to long-term retention, more durable memory representations, and successful transfer of the information (Bjork et al., 2013; D'Mello et al., 2014).

D'Mello and colleagues (2014) examined how confusion impacted knowledge on a post-test and far transfer test. The authors used an online environment where participants

interacted with two animated figures on-screen, a tutor and a peer student, discussing topics related to scientific reasoning. Participants were faced with one of four conditions: 1) both the tutor and peer agree about a concept, discussed correctly; 2) the tutor presents a correct opinion whereas the peer disagrees by advancing an incorrect opinion; 3) the tutor presents an incorrect opinion whereas the peer disagrees by presenting a correct opinion; 4) the tutor and peer agree but are both advancing incorrect opinions. The participant was then asked about their own opinion through a multiple choice item and then asked to explain their reasoning. A discussion ensued about how the case study was flawed, and over the course of the sessions, incorrect information was corrected.

Confused learners had significantly higher post-test scores for one of the contradictory conditions (true-false) over the correct agreement condition (true-true). In addition, when learners answered incorrectly after being asked for their opinions about flaws in the case study during the experiment (a way the authors inferred confusion), they were significantly more likely to detect flaws accurately in the near and far transfer problems when in one of the contradictory conditions (true-false; false-true) than when in the true-true control condition.

Accordingly, it appears that when learners had to engage in effortful strategies to resolve contradictions and their own confusions, they were more successful on knowledge and transfer tests than peers who did not experience feelings of confusion. As a result of engaging with these active and difficult strategies to resolve confusion, there seemed to be evidence that the experience of the emotion was accompanied by learning gains (D'Mello & Graesser, 2012). An overall conclusion of these studies then is that, even though confusion resolution may not always occur, when confusion resolution *is* successful, learning gains may follow.

Consequences of Being Confused

The consequences of confusion are centered around what one is able to do with this metacognitive and emotional judgment: resolve it or not. Those who are able to resolve their confusion will likely re-enter a state of engagement or flow, where an individual experiences focused concentration and attention, with complete involvement in the task (D'Mello & Graesser, 2012). Learners who exhibit confusion when processing new information tend to outperform those who do not experience confusion (Craig et al., 2004) on multiple-choice and knowledge transfer tests (D'Mello et al., 2014). Although seemingly contradictory, these effects are possible when and if students actively address the impasse they are facing, which may mean that it takes individuals longer to accomplish a task than when experiencing another epistemic emotion such as boredom (D'Mello et al., 2010). Alternatively, if a student, unable to work through an impasse on their own, reaches out for assistance and receives timely help that is scaffolded and that encourages the learner to regulate themselves, positive learning gains may be noticed (Yang et al., 2016).

Unfortunately, not being able to resolve one's confusion is a possibility. When this occurs, students can become entrenched in a progression of affect that begins with persistent confusion, which can transition to frustration (D'Mello & Graesser, 2012), and lead, ultimately, to boredom, disinterest, and disengagement (D'Mello et al., 2010; Lehman & Graesser, 2015; Taub et al., 2021). Persistent or prolonged confusion can have adverse effects on student achievement, and in the long-term, can also make students struggle to maintain involvement in a given course, leading them to drop out (Xing et al., 2019; Yang et al., 2016).

SUMMARY

Studies of confusion have focused a great deal of attention on affective experiences and on the learning outcomes associated with being confused. These investigations, largely, have been conducted experimentally in laboratory investigations as a way of empirically showing how learners experience confusion and what are its outcomes. In order to construct a fuller conceptualization of confusion and the associated processes, I conducted qualitative studies centering students' own voices and rooted in naturalistic observations. Through these investigations and the use of a grounded theory approach, I sought to bring additional depth and clarity to what students think about confusion, what are its sources and how do they recognize it, the decisions they make in response to it, the factors that impact their responses, and the eventual outcomes. Gleaning information from these studies, I aimed to provide an understanding of what confusion looks like in classrooms and in the daily lives of college students. Doing so may encourage future researchers to embed themselves in academic environments and in conversations with students, understanding their lived experiences and how to support them as they navigate confusion (for a discussion of research in authentic contexts, see Urdan & Kaplan, 2020; Watson, 2019). Although learners may be in what seems to be the same environment, they will have unique experiences; as stakeholders in learning, students benefit when there is an appreciation for the variety of ways they move through learning processes. The goal of my research project was to understand students' diverse experiences of confusion during learning through a socio-constructivist lens.

Chapter 3: Study 1 Method

For this work, I conducted two studies that built on one another. The first involved focus group interviews asking students several questions to inform an understanding of what confusion looks like from a student perspective and of how students react to confusion in the classroom. The second study involved observations of online classes where findings from the first study were considered and validated in a new environment. I followed these observations with stimulated recall interviews of students to ask when they were confused, what they were thinking, and why they had decided to take certain actions based on potential feelings of confusion.

Methodological Approach

Before delving into the methods for this project, I want to express my positionality as a socio-constructivist researcher. I take on a view that "all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context" (Crotty, 1998, p. 42). One of Alexander and colleagues' (2009) principles foundational to the nature of human learning is that learning is interactional. Social processes, of course, are part of this conception. In addition, the perspective takes into account how culture, biology, and other factors play a role in learning, recognizing that "learning does not happen in a vacuum" (p. 183). I believe this view frames how one must be attuned to the environment, culture, social setting, and a multitude of other factors that could impact and influence a learner. Moreover, although learners are frequently impacted by environments, the relationship is reciprocal, or chiasmic in nature. As a learner adapts, so does the context; as the context changes, so must the learner.

In my research investigating student experiences of confusion, I wanted to use a methodological approach that would encapsulate the reality that learners will have varied and multiple ways of interpreting, feeling, and responding to confusion at different points in their academic trajectories. A qualitative approach allows me to ask broad and open-ended questions so that I can come to understand how the participants are constructing meaning in their various academic contexts and through their relationships with others and their environment (Creswell, 2014).

GROUNDED THEORY

The data analysis process for this study was based on a grounded theory approach (Corbin & Strauss, 2008) and aimed to meet the canons of rigor for qualitative research as outlined by Corbin and Strauss (1990, 2008). Currently, there is very little literature examining how students experience and respond to confusion in their naturalistic, academic settings. Due to grounded theory's aim of exploring social processes with an emphasis on understanding a diversity of perspectives and experiences (Heath & Cowley, 2004), this framework was apt for work on conceptualizing a burgeoning theoretical process. In addition, grounded theory considers continuous analysis of the data and revision of questions to be foundational to the approach (Corbin & Strauss, 1990). This allowed me to revise and add more targeted questions over the course of the focus groups to explore specific concepts in depth. Grounded theory was most appropriate for this project as the approach is centered on the notion that a local theory is created out of the data as an explanation of a phenomenon and that it facilitates the exploration of novel experiences that have yet to be uncovered in this manner (Oh, 2019).

FOCUS GROUPS

To examine the questions I was posing through qualitative means, interviews or focus groups seemed most prudent. In comparing the two approaches, there were a few notable advantages to conducting focus groups to begin investigating the construct of confusion. When comparing approaches and outcomes of the two techniques, Coenen and their colleagues (2012) found that focus groups would lead to saturation of concepts with a fewer number of sessions than with individual interviews. Ultimately, this allowed me to reach a deeper level of detail about student experiences of confusion in a shorter amount of time than if I had conducted individual interviews. However, by having multiple focus groups, I still was able to revisit the questions after each session, refining and updating them to abide by the grounded theory approach (Corbin & Strauss, 1990).

Another distinction between interviews and focus groups is the role of the researcher. In interviews, the researcher serves as an investigator, asking questions and seeking responses. With focus groups, the researcher takes a more peripheral role as a facilitator or moderator, leaving room for the participants to be influenced by one another. The subsequent discussion should lend itself well to recognizing the multiple understandings, meanings, and norms present in the groups (Ivanoff & Hultberg, 2006; Parker & Tritter, 2006). In addition, a focus group, rather than individual interviews, was worthwhile given that I was asking students about confusion, something that is usually fleeting, and an emotion that they may not be used to verbalizing. Hearing others talk about confusion in a group setting may help someone vocalize these elusive emotions. Given these factors, using focus groups for the first study was most appropriate to begin investigating students' experiences of confusion.

Two distinct models of focus group orientation have been substantiated in the literature: an *individualist social psychology perspective* and a *social constructionist*

perspective (Ryan et al., 2014). The former is distinguished by its view that opinions are stable constructs based on an individual's thinking and reasoning (Markovà et al., 2007). This approach could be used as a means of "scoping" by asking a set of standardized questions to pretest ideas and generate hypotheses (Ryan et al., 2014). The latter is based on a foundational belief that opinions are socially shared knowledge that can be altered through interactions with others (Gergen, 1985). In this format, a narrative approach is taken where participants fill in gaps to understandings through answering *how* and *why* questions in an environment that allows for collective knowledge building (Ryan et al., 2014).

For the purpose of this project, I used a hybrid approach of these two ends of the spectrum on how to conduct focus groups. In doing so, I was able to acquire a mix of personal opinions and collective experiences. Primarily, I used a structured set of questions, but I deviated from my questions and allowed the participants to build upon each other when appropriate or when it occurred naturally. This approach is most appropriate for use with grounded theory analysis and lends itself well to developing preliminary theories (Ryan et al., 2014), which was my intent.

METHOD OF STUDY 1

The first study involved focus group interviews asking students several questions to inform an understanding of what confusion looks like and how students react to confusion in the classroom. The methods for this part of the experiment closely followed Fong and his colleagues' (2018) protocol that they implemented when investigating how constructive feedback was perceived by undergraduate students through a set of focus group interviews.

Setting

The setting for this study was an R1, large, public, southwestern university. As of 2020, the university enrolled roughly 41,000 undergraduate students and 11,000 graduate students. The majority of students reside in the state in which the university is located, with only 10% enrolling from out-of-state and another 8.3% of students coming from outside the United States. The university is similar to others in its gender representation as the majority (54.4%) of students are female.[1] Of the enrolled domestic students, they are identified as White (38.9%), Hispanic (23.4%), Asian (20.2%), Black (5.3%), Multiracial (2.7%), American Indian or Alaskan Native (0.1%), Native Hawaiian or Pacific Islander (0.1%), or their racial/ethnic identity is unknown (1.2%) or not captured due to their international status. First-generation students make up 22.8% of the undergraduate population and their four-year graduation rate is 61%; the overall four-year graduation rate is 72.2%. The majority of students (82%) live off campus, with the minority (18%) residing in college-owned, operated, or affiliated housing.

Undergraduate students apply for admission to one of 156 degree programs. Early years are populated with many large, lecture courses, whereas upper-level courses are likely to see smaller enrollments. The large classes have undergraduate and/or graduate Teaching Assistants who often lead small discussion or lab sections. Graduate students also teach a number of courses. The student to faculty ratio is 19 to 1, with 38% of classes enrolling less than 20 students, 36% enrolling between 20 and 49 students, and 26% of classes enrolling 50 or more students. The gender distribution of faculty is roughly 56.5% male and 43.5% female. For faculty, including tenured/tenure-track and non-tenure track, they are identified as White (65.7%), Hispanic (9.1%), Asian (10.8%), Black (5.1%),

[1] It should be noted that this demographic information was collected on a binary and, thus, does not represent the accurate gender identities of all students on campus.

Multiracial (1.3%), American Indian (0.3%), Hawaiian/Pacific Islander (0.3%), or their racial/ethnic identity is unknown (1.8%) or not captured due to their international status (7%).

Participants and Recruitment

Participants for this study included 27 undergraduate students. They were recruited through an educational psychology subject pool associated with a range of classes such as statistics and adolescent development, thus representing a range of ages and majors from colleges across the university. They signed up for an hour-long session, with each focus group having at most six participants. As this study was started before the university had implemented lockdown due to the COVID-19 pandemic, four of the six sessions occurred face-to-face and two took place via the Zoom meeting platform. Participants represented all class years and had a typical age range of 18 to 22 years old. They self-identified as Asian/Asian-American (8), Hispanic/Latin-American/Chicanx (8), White/European American (7), Black/African American (1), Middle Eastern/North African (1), and Multi-Ethnic (2). Participants self-reported their gender identity as female (21) and male (6). Of the students, one-third (9) were the first in their family to attend college and self-reported GPAs ranged from 2.3 to 4.0. The students were majoring in 19 distinct areas across the colleges/schools of the university.

Although there are criticisms of subject pool studies on the grounds that they are not representative of general populations (e.g., Peterson & Merunka, 2014), this seemed less relevant of a concern for a qualitative study like mine that was using grounded theory. With this approach, the goal is not to generalize findings to broader populations, but to investigate a particular group of individuals thoroughly (Corbin & Strauss, 1990). Therefore, given that I was interested in undergraduates' experience of confusion, the

subject pool, with its representation of diverse students, was a good place to begin to delve into this issue.

Procedure

Before beginning the focus group sessions, two undergraduate students, with whom I have a personal relationship, were asked to help me pilot the questions. In an informal setting, I asked them the questions I had prepared for the focus groups and encouraged them to let me know if they felt they did have an answer, what that answer might be, and if there was any language that needed updating.

This led to the addition of the purpose of my research in my introductory statement to the focus group, as these students responded that such an addition would help to provide a frame and a sense of importance for subsequent participation. Another explicit suggestion was to change the language of a question from using "ignore/avoid your confusion" to "move on from/accept your confusion." This change was intended to remove the potentially negative language associated with the earlier framing. Several other follow-up questions were added after hearing their responses. For example, for the original question of "what does confusion look like for you?," I added the question, "does this look different depending on the context?"

When participants arrived at the focus group session, which occurred face-to-face in a small seminar-style room or in a Zoom meeting, I engaged in small-talk with them to encourage a warm and open environment in addition to fostering conversation among the group (Krueger & Casey, 2015). Once everyone had entered the space, they were asked to complete a survey online and, when in-person, to put away their devices once they had finished. The survey began with the consent form, which, if any had not consented to participate, they would have been directed to the completion page and been told they could

leave. All participants who arrived at or joined a focus group session consented to the study. The survey consisted of, primarily, demographic questions. After answering those, participants were given a free-response prompt:

> Reflect on a time in an academic setting (e.g., in class, studying with friends, completing homework, etc.) where you experienced confusion. Write in the space below (1) what led to the confusion, (2) what thoughts may have gone through your head when experiencing the confusion, and (3) what decisions you made about that confusion (e.g., did you decide to keep going without addressing the confusion, did you ask someone a question, did you look to other resources?).

This exercise was intended to prime students to think about experiences of confusion so that they would have information and prior experiences to draw on in their oral responses. All participants finished within 10 to 15 minutes of the session's start time, leaving roughly 50 minutes for open questioning and discussion. Other than the participants and me acting as the researcher and interviewer, one other individual was in the room for the first four focus group sessions: a note-taker. The in-person focus group sessions were audio-recorded and later transcribed with pseudonyms to protect the participants' identities. The final two focus groups were conducted online, via Zoom, due to the COVID-19 pandemic. Due to the ability to record and have automatically generated transcriptions, the note-taker was not necessary and did not attend. The online sessions were video-recorded with the transcript edited and pseudonyms inserted after the focus groups had concluded.

At the beginning of the discussion portion of the session, I reminded the participants that there were no right or wrong answers to the questions I was about to pose, that they were free to repeat ideas others had already voiced, and that there was no limit to the amount of times one could contribute, nor the length of a response. I encouraged them to listen to each other as it may help them to remember elements of their own experiences. However, I reminded them that I did not expect a consensus to be reached for any of these

questions and that every position was good. Finally, I gave them the purpose for the research, which I generally described as a way for me to help future students be successful in their academic pursuits due to the fact that confusion is a frequent experience.

I then requested that each person contribute to the first question (Brotherson, 1994), as this would remove the initial hurdle of speaking for the first time. This question was a truncated version of the written prompt they had answered from the survey, so they were informed that they could use their writing as a jumping off point if appropriate or needed. After everyone had answered the first question, I reminded them that they could now participate whenever they felt inclined. I proceeded to ask the questions I had prepared. I did not ask all questions in each session due to time constraints or feeling I had received natural responses to them in answer to previously posed questions. However, I did ensure I asked questions from all categories in each focus group session. Due to the shift to remote instruction, for the final two focus groups, I did add online-specific questions about their experiences of confusion that were not asked of participants in the first four sessions. If time allowed, I ended the session by asking if they had general thoughts or experiences they wanted to share that were related to confusion that they had not had an opportunity to voice during the session. A list of the questions can be found in Appendix A. Participants were awarded credit for their participation after the conclusion of the focus group.

Data Analysis

To code the transcriptions of the focus group sessions, I used the analytical procedures for grounded theory as laid out by Corbin and Strauss (2008).

Theoretical Sampling

As mentioned previously, one of the tenets of grounded theory is its responsivity and flexibility to the data. Theoretical sampling is focused on the concepts that are derived from the data during analysis. These concepts then inspire new questions or foci for subsequent data collection (Corbin & Strauss, 2008). After the first four focus groups, I reflected with the note-taker about what concepts arose during the session. Following the online sessions, I wrote a short synthesis of salient ideas.

I used these conversations with the note-taker to spur additional questions and/or different phrasing of questions. For example, after the first focus group session where students voiced how confusion led to feelings of inadequacy or believing they were stupid, I decided it was important to consider if others shared this view. For the subsequent focus groups, I added the question "Some students have said confusion has a negative connotation. What are your reactions to this?" Another example occurred in the fourth focus group session. After disparate responses to the question "how often do you recognize you are confused?," the note-taker asked me to clarify what I meant. In doing so, it led to the rephrasing of the question to be "are there times when you feel your confusion goes unrecognized?" By having a reflective process in place after every focus group where I revised my questions, I was able to ensure each session led to more effective data collection.

Open Coding

To begin the coding process, Corbin and Strauss (2008) called for researchers to consider all possible meanings and to examine the context before determining labels for concepts or categories. Concepts can range from low- to high-level, with high-level concepts considered to be *categories* or *themes*. Researchers are tasked with breaking down

the data into discrete parts, which may include dimensions and properties, categorizing them into smaller groups, and subsequently labeling all parts with representative names.

Axial Coding

Axial coding is closely related to and often occurs during open coding. As the researcher breaks down the concepts during open coding, they also must work to relate the concepts and categories back to one another (Corbin & Strauss, 2008). These connections are intended to lead to broader themes, and to an organization of categories into a hierarchy.

Comparative Analysis

Once concepts and categories are created, it is important to look through the data to note similarities and differences. Incidents that are similar can be given the same label or code. However, the differences in each can aid in expanding the property and dimension of the concept.

Integration

The last analytical step in grounded theory is integration. After revisiting the data, the researcher strives to understand how all the categories fit together. The goal, ultimately, is to find a core category, or main theme of the research, that all categories can be linked to/around, and then to refine the resulting construction. Once all categories and their properties, dimensions, and variations are accounted for, saturation is reached. Although variations may arise in future data collection, the conceptualization is unlikely to change (Corbin & Strauss, 2008).

Data Trustworthiness

Credibility

To account for Lincoln and Guba's (1985) concerns with the criterion of credibility, or the "truth" of the findings, peer debriefing was used during my analysis. I took part in the focus groups and constructed the first set of categories from coding the data. After doing so, I met with another researcher to conduct subsequent analyses and refinements (Woodruff & Schallert, 2008). Member checking, also, was used to check the possibility of misinterpreting what a participant had contributed. Final decisions were made through consensus among my peer debriefers, with iterations of concepts and categories being made throughout the process. Ultimately, three rounds of coding were conducted with this set of transcripts.

Transferability

The application of findings to situations or contexts outside of the original study, also known as transferability (Krefting, 1991), is a concern of qualitative data. However, Lincoln and Guba (1985) asserted that the onus of transferability is not on the researcher, but on the individual who is considering the application of findings outside the original context. The researcher, therefore, is responsible for providing thick descriptions of the context, participants, and data to allow for proper comparison. Throughout my methods and results, I aimed to be as descriptive as possible to ensure future researchers could apply these findings appropriately.

Dependability

Dependability considers the consistency of the data and how repeatable are discovering these findings (Lincoln & Guba, 1985). Within the notion of dependability,

however, is a recognition that situations, contexts, and experiences are variable. Thus, non-normative or outlying data should still be included as a way to consider the boundaries of a phenomenon (Krefting, 1991). In addition, similar to transferability, a description of the participants and context is important to ensure the dependability of results. Through the inclusion of a description of the participants and context, I aimed to meet the criterion of dependability so that the findings could be replicated with similar participants and contexts.

Confirmability

The neutrality and objectivity of a researcher is necessary to ensure the findings are an accurate representation of the participants' experiences and contributions (Krefting, 1991; Lincoln & Guba, 1985). The triangulation of multiple data sources and the use of multiple analysts can protect against bias. One way I aimed to achieve this kind of triangulation was by connecting the brief statements participants wrote before the focus group discussions began as a way to concretize their oral contributions. In addition, I discussed the analyses and solicited the different perspectives of my fellow researcher to ensure I met the standards of *confirmability.*

Chapter 4: Study 1 Findings

The results I describe here are based on the transcriptions of six focus groups and three rounds of coding. The first coding foray led to the identification of 178 concepts from analyzing the responses of the focus groups. Through further coding, aiming to find similarities, I noted seven categories. By the second round of coding, I had identified 32 dimensions within these categories; the third round resulted in refined categories and 23 dimensions. Below I frame each of these overarching categories as a question and delve into specific elements of confusion: how it is perceived, recognized, and addressed. The categories have a range of two to five dimensions that represent the responses participants gave in the focus group conversations.

Table 1: Categories Derived from Similar Concepts through Open Coding

1. What do people think about confusion?	**4. When do people recognize confusion?**
Negative	During comprehension
Useful	During application
2. What is the source of confusion?	**5. How do people respond to confusion?**
Prior knowledge	Seek sources or resources
Preparation	Disengagement
Classroom experiences or environment	Move on/Ignore
Perceived distinctiveness	**6. What impacts how people respond to confusion?**
Affective state	Prior experiences
3. How does confusion feel?	Motivational factors
Frustration or anxiety	Environmental or contextual factors
Self-conscious	Cultural or personal factors
Impasse	**7. What is the result of confusion?**
Changing	Unresolved
Responsibility	Resolved

WHAT DO PEOPLE THINK ABOUT CONFUSION?

Before delving into questions related to how students experienced or moved through confusion, I thought it important to develop a baseline understanding of students' thoughts about confusion. Two primary categories emerged from participant responses: that confusion was perceived negatively, though it was useful for learning.

Negative

When asking participants how it felt to be confused, they frequently discussed how there was a strong negative connotation associated with the construct. This negativity played out at both a personal and a societal/community level and was expressed by ten participants across four focus groups.

Personal

For seven students, confusion was negative in a personal sense. Some brought up how the environment impacted their personal feelings, with Saachi (pseudonym) noting that confusion was "very negative," but only in school. Jasper considered how being the only one confused is negative "because then you start thinking like, 'Am I cut out for this? Like, what am I going to do?' Like you start thinking all these negative things like 'What if I fail this class?'" Meanwhile, Jung tied in his perception of himself as being impatient and wanting to learn quickly as leading to perceiving confusion negatively:

> It's, like, really easy to perceive confusion as negative because it almost seems like a hindrance to, like, your learning. Because it's like now you have to put in more eff--more work to understand something that it seems like other people could understand without any confusion. So it seems like, it just seems like one extra step or like one obstacle...while you're learning something.

The participants exemplified how confusion can be deemed negative from a personal scope or perspective, introducing the internal thought processes they have when experiencing it.

Societal/Communal

A larger scope for interpreting confusion was implied by five students, noting that there are stigmas and negative connotations associated with it. The difference in the responses students gave that were coded into this category as compared to "personal" was from where the source of negativity came. In the case of personal, participants described

their own justification or personal experiences for its negativity. At the societal or communal level, students used general language, not ascribing a source, to describe why confusion was negative. This generality came about when considering why students would not voice confusions publicly during class: "I feel like there's also some sort of shame? Or some sort of embarrassment associated with being confused" (Jung). Conversely, Mabel labeled "our society" as a source of negativity, saying that it

> ...fostered the idea that you just got to know where you're going or what you're doing. You know, if you don't know that then you're stupid, and so I think that's kind of where confusion gets a lot of its negative connotation from.

Mirroring Mabel's language, Usaf and Jorge also mentioned confusion's "negative connotation" or "bad" stigma, mentioning that individuals should know what they are doing and that if they do not, they may be considered "stupid." These perceptions of confusion may have negative impacts on how students plan to address confusion, specifically if they do not want to make their experience public. Although many students reported confusion as negative, this did not preclude them from having alternative interpretations.

Useful

Fourteen participants, including seven of those who felt it was negative, reported an appreciation for confusion, finding it useful for learning. Confusion was seen as a "good indicator of [...] how well you comprehend the material they teach you in class" (Ariana) or of "whether you're retaining knowledge or not" (Jung), providing metacognitive cues to "refresh over that and maybe rewatch the lecture and help you comprehend it better" (Ariana) or to help one "determine what you need to study more, or like what topics you need to spend more time on" (Kara). Usaf tied confusion to metacognition as well,

reflecting that it helps "you to, like, take the time to pause and think about what's going on so you can, like, think, like, what do I actually know and what do I not know. Which is a good thing." Students found confusion to be productive from a metacognitive standpoint, helping them to recognize content areas in which they needed to devote more attention.

Participants also reported confusion serving as a type of desirable difficulty, where they would expend additional effort that would lead to "more learning" (Aurelia). Selena discussed this utility of confusion for, in her case, long-term learning:

> Because when you do that extra effort to learn something, then it sticks better in your brain. So like a month, two months after, you're gonna be like 'Oh yeah, I know that topic,' just because you actually had to work to understand it. When things come easier, they just click, they're easy for them to just...to just forget about them. So I think [confusion is] very necessary for learning.

Thus, students seemed to recognize that the disfluency they face when confused may lead them to engage in productive, though effortful strategies that foster deep learning. Also contrasting with content that can be integrated with ease into their knowledge base, Rowan discussed how aspects about which she is confused, ones where she takes "more time to figure out, are the things that stick more-long term." Whereas extended time spent resolving confusion was an element Rowan and Sudena reported, four others discussed how confusion is productive because it leads to engagement and question generation, elements that multiple students felt were necessary for learning. Jorge expanded on the question generating idea, discussing how "confusion kind of builds those connections in your mind," where the "more you ask [questions], the more you'll learn, the more you'll be able to associate and activate your meaningful learning rather than rote learning." Ultimately, half of the participants in these focus groups identified confusion as productive for learning, with Saachi going as far as to say, "I actually appreciate and almost encourage confusion." Thus, students appeared to grapple with these dueling perceptions of and

experiences with confusion: that it is negative for them, it is often seen as negative to be confused, but that moving through the process of confusion successfully will lead them to long-term learning of complex content.

WHAT IS THE SOURCE OF CONFUSION?

After learning about what students thought of confusion, the next category explored one of the first stages of the confusion process: how confusion arises. In this section, I will expand upon five sources of confusion: prior knowledge, preparation, outsider status, affective state, and classroom experiences/environment.

Prior Knowledge

A frequently mentioned occurrence of a time when students recognized they were confused was during learning, a point I will expand upon in a later section. It appears that one reason for this may be due to a lack of prior knowledge as learners face difficulties integrating new information into their existing knowledge networks. Seven participants voiced two primary situations resulting in confusion: taking courses outside of their major disciplines or outside of a recommended sequence and during class time when professors are employing new ideas for which students do not have a foundation or have a weak foundation.

At this institution, a university where the vast majority of students apply to their major program before enrolling, learners find strong distinctions between their in- and out-of-major courses. For Naima and Gianna, their lack of prior knowledge in outside disciplines caused them to be confused, "since I'm not a science major, all the classes I've taken, [...] I don't really know much about, I struggle the most. And I feel like I tend to be more confused in those classes" (Naima). Gianna expanded on this internal struggle,

discussing how her lack of prior knowledge was emphasized in a fast-paced and out-of-discipline environment:

> I didn't have much experience with film [...] and I felt like I was the only one that was lost because the teacher would um...she'd usually speed through her lessons [...] and she'd use, like, really complicated terms. [...] And so I just felt, like, confused throughout the whole semester.

Although out-of-major coursework was a precursor to confusion for some students, others reported lack of prior knowledge to be a source of confusion even in their major specific classes.

For a student like Zhou, he expressed similar sentiments as Gianna in terms of his lack of prior knowledge being exacerbated by the professor, causing confusion. In his experience,

> ...whenever the professor try to, like, define a new concept or to use new concepts that she hasn't talked about yet, and then, like, she will just keep building up so that as she's building up, there are just different holes down there that are, I guess, not being filled yet. So that as they add up, I just start to become very confused.

Zhou specifically voiced this idea of "holes," that I interpret to be gaps in his understanding of the given concept. Whereas having prior knowledge may have allowed him to connect the new information, potentially filling holes, he reported that without the foundation, his knowledge network was incomplete. The experiences and perspectives students offered in the formation of this category were primarily focused on a missing foundation, of no fault of their own, that was exacerbated in class sessions. However, participants also voiced that their decisions and actions in preparing for classes were sources of confusion, to which I turn next.

Preparation

The experiences of the nine participants who discussed preparation were mixed in terms of what did or did not serve as a source of confusion. In terms of reading, many felt that not completing assigned readings before class made them more confused than when they did read. However, there were others who discussed how some readings were unproductive to complete prior to discussing ideas in class. In Lily's case, reading a textbook that conflicted with the professor's presentation made preparing for class a cause of confusion, "you're just going to get [...] more confused cause you're like 'oh, well the textbook said this, but you're not talking about this and you're explaining it a different way.'" Kara presented another counterexample where a complicated textbook like the one from her biochemistry class would pose problems, as she "would spend longer and get more confused trying to force [her]self to understand it." However, once students were in class, being prepared was generally seen as productive in mitigating confusion. Specifically, when classes were formatted in ways that required students to engage actively with the material through in-class quizzes, a flipped classroom model, discussion, or "cold-calling" (the practice of calling on a student when the student has not raised their hand), being unprepared for class led to confusion.

Classroom Experiences or Environment

When considering what leads them to feel confused, twelve participants identified three primary factors related to classrooms. One was professor characteristics. This category included elements related to the rate of delivery of instruction, an accent that was unfamiliar or difficult to understand for the individual, and how the instructor explained or taught content. If a professor spoke quickly and in a way that was not engaging, some participants felt these characteristics would lead them to experience confusion. For

example, when a professor was “monotone” or “boring,” Krista and Klarissa found themselves tuning out during class, leading to them experiencing confusion. Another characteristic a student mentioned as a source of their confusion was their professor’s organization. For Erin, when the professor would go on tangents or make references to topics and ideas she felt were disconnected from the to-be-learned information at hand, she experienced confusion.

The second factor was distractions. Rowan reflected on a specific moment of distraction that occurred during class:

> And so I got very confused during that learning experience just because I wasn’t actually focusing on what he [the professor] was saying. It was more so like trying to figure out where in the notes he was talking about, or like what he was addressing.

Classroom distractors have the ability to cause students to lose focus and miss important material or explanations, leading to confusion, an element that was extremely salient in online learning environments.

The last factor was learning online. Participants in the final two focus groups reflected on how learning in online classrooms was impacting their experiences of confusion, with learners discussing varied, new sources. Confusion occurred when the professor did not have cues to slow down or clarify points because students had their cameras off (Zan). Participants were also distracted by poor self-regulation during class time, “it’s a lot easier to be distracted when you can have other tabs open at the same time [...] which can add to confusion, you know, not paying attention which makes you confused” (Jeffrey). Additionally, the lack of structure in the physical environment resulted in a decline in self-regulation for some students, as when Freya found herself falling behind

on readings and "zoning out" in class. This drastic change in environment was a definitive source of confusion in classes such as labs:

> I definitely feel like what I have gained out of [lab] has gone down a solid 50% because I'm not the one actually doing it and like understanding how each thing affects something else. So that class, I've had a lot of confusion in, especially. (Melanie)

The environment served as a significant source of confusion for many students. However, they also introduced personal factors that caused confusion.

Perceived Distinctiveness

Five students who perceived themselves as "distinct" or "different" commented on how this status catalyzed their confusion. The most frequent description came from students describing taking coursework outside of their majors, "I'm taking a geology course this semester, and I'm a [film] major, I'm more inclined towards the arts, not so much the sciences [...] so I'm very often confused in that class" (Klarissa). Oftentimes not explicated by the students, participants may have drawn on senses of preparation and prior knowledge or belonging in judgments of distinctiveness. Although distinction status was salient for those enrolling in classes outside of their major, some participants mentioned their perceptions of themselves as different in certain domains, feeling confused "especially when it comes to classes that are math-based, just because I'm also inclined to the humanity courses" (Selena). Another student drew on distinctiveness, including languages, that caused confusion,

> English is not my first language. [When the professor] explain something and I feel like that's not what I understand. But then no one has questions about it. So I assume maybe...it's just me like...not understand it in the English version [...] that's what causing me confused most for lectures. (Zan)

Students' positionality as distinctive in their learning environments served as a source of confusion for some.

Affective State

Another personal factor that caused confusion was participants' affective states, particularly when in class. For example, Kai reported feeling overwhelmed by commitments outside of class that led to being "so tired that I can't really comprehend what the professor is saying." A few participants reported that feeling overwhelmed, tired, or anxious may cause them to be distracted and tune out, contributing to their confusion.

HOW DOES CONFUSION FEEL?

For learners experiencing confusion, emotions were commonly expressed as close consequences. Twenty out of 27 participants made comments related to affect when reflecting on their experiences of confusion, indicating its widespread salience and importance to learners. I created five categories organizing how participants interpreted the feelings associated with confusion.

Frustration or Anxiety

The feelings participants most frequently reported when considering their experiences of confusion were frustration and anxiety. When faced with confusion, students would find themselves saying "'Ahh this should be clicking! Why is it not?' And it starts to lead to frustration" (Jorge). Although it was common to report feeling frustrated when not understanding something easily, for some, frustration stemmed from a lack of knowing how to resolve the confusion: "it can feel very frustrating when you're very confused, and you're by yourself, and you don't have anyone to help you figure it out" (Jung). Participants expressed they felt frustrated when confusion was self-imposed (e.g.,

lack of studying) or when they compared themselves to peers who seemed not to show confusion, as Saachi did, reporting "I get very frustrated when I am confused just because it seems that my peers aren't getting confused, and they're able to, like, pick up on things, and so I feel stupid and, like, incompetent." Frustration, commonly, was associated with feelings of stupidity or incompetence, with these heightened the closer students were to an exam or assessment. Alternatively, participants experienced frustration when they did not understand a foundational concept at the beginning of a lecture, specifically when other ideas built on it and they could not resolve the initial confusion (Jorge). Feeling frustrated or stressed deterred at least one student from working to resolve the confusion (Sudena: "I get annoyed and frustrated and I don't want to do it anymore"), indicating that these emotions may inhibit students from engaging in strategies, directing them to ignore their confusions, at least temporarily.

Anxiety stemmed from considering outcomes when learners could not resolve confusion, thinking "I'm gonna fail the midterm or I'm gonna fail the final. And you start worrying about the pressure that you have to succeed as a student" (Gianna). For a first-year student like Kai, experiencing confusion was anxiety-inducing because it was new and because she was experiencing new stresses. She expressed, "when I'm confused, I get really anxious about myself because, like, um...in high school and stuff, like, everything was fine." Her anxiety was compounded when considering her confusion of material before a midterm. Kai's experiences may illustrate that students who have generally experienced little difficulty in their learning processes before college may not come to the novel environment of a university with adaptive tactics for coping with confusion. Students also reported anxiety when considering their state relative to their peers: were others "getting it?" For these participants, maintaining their intelligence in the face of others seemed important.

Self-Consciousness

Comparison to others was a frequent norm expressed by nine students in the focus groups. Participants described concerns of confusion making them feel insecure, bad, or "stupid cause I was like how can I not understand what they're saying, like, others can" (Naima). Although participants' interpretations of their peers' understandings were, typically, without evidence (i.e., believing others understood content without validation of that fact), class discussions or testing provided direct feedback for comparison. In one of Kara's classes, her professor interspersed public quiz questions during lectures that made her think if she was confused "on those questions but other people around me know how to solve it, that kind of makes it worse. Because then I'm like, 'Oh, what did I not catch within the last five minutes that I should have caught?'" There seemed to be a certain amount of pressure that came with comparing oneself to peers in the class, and confusion led to a heightened sense of being self-conscious when having that experience.

For two women, in particular, feelings of self-consciousness related to stereotype-threat were heightened due to taking classes in male-dominated areas such as STEM. Lily discussed self-consciousness as a frequent emotion accompanying confusion: "I feel like this a lot especially being in a male-dominant major [...because] you don't want to seem dumb." Saachi also reported this feeling, though differing slightly in language from Lily in wanting to avoid being perceived as "incompetent:"

> I also felt kind of embarrassed [asking a question in class] because it's a class where there are a lot of guys [...] And that kind of intimidat--intimidated me as well because I didn't want people to think that I was incompetent. Which is a feeling that I experience a lot in my STEM classes.

Confusion and self-conscious feelings arose for students across domains. However, for those in disciplines where they are at a heightened risk of stereotype threat, such as women

in a STEM course, learners may benefit from more direct communications about the benefits of experiencing confusion to protect against the self-conscious feelings that can arise.

Impasse

To seven participants across the focus groups, confusion made them feel that they had reached an impasse. For some, it manifested itself as a gut feeling (Kai), feeling lost (Jung), or not having ideas "flow" (Mabel). Confusion led to students having feelings of "not knowing how to do something" (Erin), and "having more of a, like, a complete block" (Usaf). The majority of students who expressed sentiments falling in this category felt that once confused, they did not know what to do. Providing students with toolboxes for coping with and addressing confusion could help to scaffold learners out of these feelings of impasse.

Changeable

Although at times leading to feelings of being at an impasse, six participants expressed confusion as seeming a part of a process of learning; confusion was seen, not as an end, but a changeable state, "it's not something that's always gonna be there" (Mabel). Participants felt that confusion could be addressed later (Kara), where after reflecting on "what do I actually know and what do I not know" (Usaf), they could "work harder to understand it" (Emma) through reviewing material again (Selena) or getting help, leading them to "learn more cause you put more effort into learning" (Aurelia). Although confusion could be something that felt conquerable, it was the responsibility of the students to employ appropriate strategies to reach a resolution.

Responsibility

Participants recognized that confusion was not a passive state they would move through without attention. Rather, seven students expressed how they felt confusion resulted in a sense of responsibility to take action in their learning processes. Although frequently interpreted in a neutral way of needing to address confusion, Lily, for example, tied responsibility to a belief that "sometimes my confusion was my own fault, because, like, I just don't really care what the professor's teaching, so then I don't really pay close enough attention." Others did not necessarily reflect that confusion was their "fault," but they almost unanimously tied a sense of responsibility to processes related to resolving confusion. For some, the responsibility came to light at the beginning of the process, that the "confusion that I have, it's on me now" (Gema), or telling themselves "I need to get on top of [the confusion] and then find that in your...just your motivation to resolve that" (Freya). Looking at a later stage in the process, Melanie stressed the importance of engaging with resources, where confusion "requires you to go out of your way to do, like, additional work and, like, looking things up and doing additional research." It appears that experiencing a sense of responsibility after confusion may prompt learners to engage in active strategies to resolve their impasses.

WHEN DO PEOPLE RECOGNIZE CONFUSION?

Confusion could be fleeting or go by unrecognized. Metacognitive failures are not uncommon in learning, a label applied to the experience of not knowing what one does not know. In this coding category, participants considered ways or situations in which they were able to recognize when they were confused. Learners recognized confusion at two distinct points in the learning process: when comprehending new information and when applying new knowledge.

During Comprehension

The primary spaces in which students recognized confusion during the comprehension process were in class. Students described noticing they were confused "when you're intaking the information, you, like, I guess, take it the wrong way" (Krista) or when "my understanding of the lecture is different from the professor's understanding" (Zan). Rather than occurring at one, specific point, Heather described that she experienced a more gradual rise to confusion that resulted in recognition after "a professor, like, says something that you don't understand and keeps going and building up from there." Confusion, for students, may not be a "switch" or result in immediately determining they are confused. Instead, it may take time to reach a threshold for accepting or recognizing their confusion.

Confusion may also be more or less recognizable for students depending on features of the course and their personal characteristics. For example, Jasper reflected:

> I usually recognize [confusion] in class [...because] most of my classes are building on previous things that we touched upon. So I feel like I have a really good, like, background knowledge [...] So whenever [...] I don't understand it, then I usually, like I said, realize it in class.

As evidenced by the students' comments, recognizing confusion during learning may come about through multiple pathways, including when content is not understood, misunderstood, or not able to be integrated seamlessly with prior knowledge.

During Application

Twelve participants stated that completing assignments or application-based homework led them to recognize they were confused. Eight of these participants mentioned thinking they had understood course content during class, but then realizing this judgment was incorrect upon engaging in outside work (Jung: "I don't really realize [I'm confused]

until I am trying to, I guess, go through the information again on my own;" Klarissa: "I'm doing a problem on my own, I'm like, wait. What was the next step? Maybe I didn't understand those as clearly as I thought I did in class"). A frequent point of recognition was when "I have to study for an exam or I'm reviewing material" (Selena). When studying, reviewing content, synthesizing concepts, or completing homework, participants had an opportunity to recognize confusion as they were required to make sense of the material on their own.

Interest or engagement may facilitate confusion recognition. Lily reflected that when she had been disengaged from the material, "I don't really pay close enough attention, and then when homework comes around, it's like, 'Oh. I should have been paying attention in class, he probably said what that was, but I didn't really care.'" Facilitating active engagement among students during class time may help them to recognize confusion during class as opposed to finding out after leaving the room, using tools like "poll questions in class where they're quizzing you on the material they just presented" (Kara). The active strategies learners engage in when applying new knowledge, the same ones that facilitate metacognition recognition, may also be pertinent for recognizing confusion.

HOW DO PEOPLE RESPOND, BEHAVIORALLY, TO CONFUSION?

Among the 25 participants who made comments related to their behaviors in response to confusion, three actions emerged. When deciding to attempt resolution, participants voiced they would seek sources or resources for support. Alternatively, students would decide to disengage, an action they presented as temporary in nature. The disengagement could be more permanent, however, as when learners chose to move on from or ignore their confusion.

Seek Sources or Resources

When deciding to take action to resolve confusion, participants described seeking some sort of aid. No participants voiced that they would sit with the confusion and strive to resolve it without outside help. This help came in the form of seeking their own resources, turning to others, or searching online.

Self

Notably, students saw themselves as an important resource for resolving their confusion. Learners voiced that they would work to "clear things up through the textbook or whatever resources I have" (Kara), complete examples or practice problems, rewatch lectures, or revisit slides. Engaging with materials provided by the professor or directly tied to the class was a popular choice among students, hoping they could "catch what I missed" (Ariana) or "see if I understand it" (Klarissa). When participants mentioned a process of confusion or multiple steps that were involved in their triaging, their first action, typically, was working on their own. For example, if Rowan was confused during class, she took steps to prepare for being able to start the process of resolution on her own:

> I will, like, write in the margins the time so I can just go back and listen to that one part. And if it doesn't click after I review it again, then I'll usually go to my textbook and try to figure out what it's saying in there. And then if it still doesn't click, going to a different source like going online and then asking my peers.

The students believed that they were resourceful and could successfully resolve, or at least attempt to resolve their confusion in a meaningful way. These sources they accessed were helpful when an individual felt that they could piece together and resolve their confusion on their own. Otherwise, they resorted to resources beyond the scope of the class.

Others

There were several "others" whom participants expressed they would reach out to when feeling confused. Four students identified peers as a common source for resolving confusion. In person, participants engaged in this behavior casually during class by asking their neighbor, "you get what they're saying?" (Erin), through seeking peers' perspectives at study groups, with a "study buddy [...], even if I'm a little confused, we'll go through it together" (Mabel), or with a friend either in the class or who had taken it previously.

Professors, TAs, and tutors served as additional sources of help for participants. Some indicated they had a sequential process for resolving confusion, as with Saachi whose "first solution is to go to a friend and try to talk it out with them and understand the material. And after that, if it's still not clicking, then I'll consider going to the TA." Others considered how accessible resources were, with Jeffrey finding "the easier it is to get access with TAs, the less confusion there usually is because the TAs can usually get you put in contact with the right answer pretty quickly [...] that's, like, the best way to deal with [confusion]." A few students felt comfortable asking professors questions during or after class time, but if not, office hours or email were the avenues students chose to seek help from professors and TAs. Jasper expressed that "there's just a difference between a peer explaining something and then, like, an instructor explaining something," indicating how he discerned a distinction between the utility of these two sources. I will report on the reasons why participants chose to engage with certain sources over others in the following section. To continue with turning to others, participants also referenced technologically enriched communications when seeking help for confusion.

When learning remotely, Jeffrey continued to see his peers as effective sources of help but had to turn to technology to assist the process. Rather than meeting physically to ask questions, he said that he would "FaceTime somebody who's in the class with me and

try to, like, discuss that [confusion].” Though live communication was a possibility, the primary way students communicated through technological means was asynchronously. Both in-person and when transitioning online, participants noted the group messaging app “GroupMe” as a site for asking help from a large swath of peers. At UT Austin, there is a culture of creating a “class GroupMe” for a given course so that students have a site for connecting with one another and asking questions disconnected from the professor. Students expressed using this space to ask for “help for things” generally (Femi), ask about “small questions, because everyone’s answering them” (Freya), or “something that seemed really important that I miss[ed]” (Krista). A place to commiserate with peers facing similar circumstances, it can be productive to ask, as Krista mentioned, “‘Who else, is confused?’ [...then] there are other students that are in the same class, but like, somehow they’re not confused, and then they kind of like teach it, but in like a different way how they understood it.” Rather than seeking help from one student, in particular, GroupMe allows for a more general canvassing that can aid in resolving confusion.

Online

Another resource participants employed to help resolve their confusion was the internet. Although it could be classified under the category of “self,” as learners are searching on their own for support, oftentimes, they turned online because they were searching for explanations from others. Requiring learners to have targeted questions or confusions in mind, six participants discussed how they would turn to Chegg, Google, YouTube, or Khan Academy for support. Sources like Chegg or Google may be able to walk through specific problems with which students had difficulties, but participants accessed platforms such as YouTube and Khan Academy to learn about troublesome concepts through the help of alternative explanations. Participants showed themselves to

be resourceful, needing to recognize when they could not ameliorate confusion individually, determining about what they were confused, before using targeted searches to support their resolution processes.

Disengagement

Rather than addressing their confusion, sometimes students chose to disengage from the learning experience. Within the scope of these focus groups, nine students indicated zoning or tuning out when confused. Some indicated this was because "I'm just going to learn it later because they're not teaching it in a good way" (Erin). This behavior may be protective as it blocks students from experiencing negative emotions (Do & Schallert, 2004), like Heather who shared, "If I know I'm not gonna understand it, sometimes I'll [...] shut down because I get kind of frustrated." Saachi also distinguished how this disengagement manifests in different types of classes:

> In lecture-based classes where I should be taking notes...when I'm confused, I tend to not engage with the material. So like not taking notes, like, not even attempting to make sense of what's being said. Um, sometimes in more, like, discussion-based or hands-on classes, this means that I'm not engaging with my peers as much because I don't want to say something that doesn't really relate to the content.

In Saachi's case, this disengagement could be protecting her from outing herself as being confused. The most frequently expressed sentiment related to disengaging was the sense that it was not "worth it" to expend the effort to continue paying attention in class when confusion had set in. Participants recognized they would need to return to content later to resolve the early impasse, so they opted to reserve their energy rather than expend it struggling to keep up and make sense of the content. The participants in this category expressed disengagements in response to confusion that resulted in them, effectively,

removing themselves from the learning environment. Other actions included temporarily or permanently moving on from confusion.

Move On or Ignore

Participants reflected that they did not always attempt to or successfully resolve their confusions. Rather, 14 of them expressed comments about times when they would move on from or ignore their confusion. As a reminder, though students will almost certainly experience times where they are confused but do not detect that is the case, in this section, I am discussing students who recognize their confusion but make an active decision to ignore it.

The actions students took when moving on from their confusion, sometimes, was a temporary break. Participants expressed tactics like how they would "put a star next to the note that I'm confused on, and then outside of class, I'll look it up or look in the textbook" (Aurelia), or that they need to be "taking a step back from it and then coming back later with a fresh mind. Cause, oftentimes when you're frustrated, you have all these emotions going on through your head and it gets harder to learn" (Jasper). For others, they determined that resolving the confusion was not worth the effort (Heather: "If I'm really frustrated and it's not something that is gonna hurt me too bad if I don't understand it, then my instinct is just to give up because it's stressful"). These participants indicated that they had personal strategies for indicating a temporary break from confusion, whereas others responded more to affective cues, determining whether it was worth moving on from or permanently ignoring their confusions.

The environment also played a role in students' actions. When transitioning to online courses and learning in a remote environment, Zan felt that in online learning, "I chose to move on more often than I would in the classroom." Melanie expressed similar

sentiments where, now being online and removed from the physical academic environment, she noted that "if I can't figure it out, I just kind of don't." For Freya, being online made it "easier to just fall into the habit of letting [go] or [...] ignoring my confusion." The reasons why students made these decisions about how to address their confusion appeared to be based on both personal and environmental factors.

WHAT IMPACTS HOW PEOPLE RESPOND TO CONFUSION?

Students do not make decisions about their learning experiences in a vacuum. Rather, learners consider their previous experiences attempting to resolve confusion, their motivational factors, cultural or personal factors, and characteristics of the environment when determining how to respond to confusion.

Prior Experiences

Eleven participants described previous experiences that were successful and unsuccessful in resolving their confusion, and how those impacted their responses to it at their current stage in their academic careers. Half of the participants who discussed going to office hours or asking authority members for help had successes, saying that this process became more comfortable over time. For example, Jung, reflected on how positive experiences had shaped future experiences with confusion, "the very first time I [asked TAs or professor questions], afterwards I was saying, 'Oh that wasn't that big of a deal.' So then I started to do it more frequently." Challenging preconceptions of what seeking help from others might feel like or how productive the session may be can lead students to engage with broad resources. In Usaf's case, he found himself struggling for several hours as he attempted to solve class problems on his own. After attending office hours, he realized, "if I just go to office hours and ask the question, then I find I'm actually finishing

the question in like 20 to 25 minutes versus an hour, so, like, I'm actually saving more time."

Unfortunately, the resources students chose or the ways they attempted to resolve confusion did not always result in positive experiences. Participants were sometimes unsuccessful when asking for help in that those they asked did not assist in resolving confusion. This experience had the potential to color future experiences, as with Gianna who thought she had "stereotyped TAs in a way...because I had one experience last semester with a TA [...who] just made it worse. So after that, I just never went to a TA because I felt like they'd be the same." Besides having "bad" experiences with them, Klarissa also reflected how TAs sometimes "don't explain things the way...the professor does, or it's different, or it's weird. So I'd rather not put myself in a more confusing situation." If participants do not feel they can trust sources of help, or that they will alleviate their impasses, they may choose to rely on other supports for resolving confusion.

How the sources scaffolded their helping response also played a role in participants determining whether or not to engage with them. Erin, who previously expressed general comfort in asking questions of the professor during class time to resolve confusion, stated she would not engage in this behavior for one specific instructor:

> If you ask a question, he, like, kind of makes you answer it yourself, he'll be like… 'Well, what does this mean?' And then you have to say the answer, and then he'll be like, 'And then, what does this mean?' And you'll have to answer. So I--I wouldn't ask a question in that class because I'm, like, well what if I don't know the answer to something he asks me?

For a student like Erin, the professor scaffolding her to resolve her own confusion was not productive, or at the very least, was anxiety-inducing. Knowing this is how he responded to students' questions impacted her confusion response, and though she may ask questions during class in most of her courses, she would avoid doing so in this one. Previous

experiences also helped at least one participant to calibrate the distinction between knowing when they could resolve confusion on their own or when they would need help from others, helping them to choose the most effective route for addressing their confusion.

Motivational Factors

Thirteen participants made distinct comments about how motivational factors would impact their responses to confusion, comments I interpreted to reflect how goal orientations (Ames, 1992; Elliott & Dweck, 1988) were guiding their choices. Students have different goals for the classes they take, and these orientations impact how they respond to confusion. Although many of these distinctions students voiced as originating in whether a class was in- or out-of-major, it was clear their goal orientations also differed. Students often expressed a mastery approach with courses in their major, saying "I want to make sure I'm actually learning it and make it stick [...] I put more effort into getting outside help when I'm confused for those classes" (Aurelia). Performance approaches still motivated students to resolve their confusion "not necessarily because I want to understand it, which I should. But because I have maybe, like, an exam next week, I can't be confused about this" (Kai). For others, the performance approach gave them a justification to ignore their confusions (Sudena: "If the material, like, isn't as important, or that I know it isn't going to come up again ever, then I kind of just move past it"). Commonly, participants reported a mastery orientation for in-major courses and a performance one for those that were out-of-major. Thus, their goal orientations impacted how students responded to confusion, differentiating their actions across classes.

Although goal orientation seemed the most frequent basis for motivational factors impacting responses to confusion, I also saw students discussing motivational factors that seemed connected to how interest, self-efficacy, utility-value, and relatedness could

determine how worthwhile it was to attempt resolution of their confusion. For Jeffrey, when these factors were absent, he was inclined to ignore his confusion: "classes that don't have to do with your career aspirations, that are really difficult, and like you don't have anybody else you know in the class [...] I can put tons of effort into this and I'll still be confused." These motivational factors typically directed students toward making a decision to attempt or not attempt to resolve confusion, but also interacted with the environment, impacting the participants.

When transitioning to online coursework, participants felt the shift in environment and circumstances differentially impacted their motivations, and ultimately, choices for resolving confusion. For Heather and Melanie, moving online led them to have a "hard time, like, finding motivation to do all this outside work" (Melanie) to resolve confusion. Zan, on the other hand, embraced the new setting and the cultural shifts that came with it:

> I feel more motivated to solve my confusion now [online] because after, like, this quarantine thing, it's everyone. And I feel like people are more understanding that we are confused. So my...all of my professors are providing solutions, and they're open to see if they can help us with anything. And that really helped me to start to solve my confusions and stuff in the class.

The relatedness and community Zan felt helped to catalyze her attempts at resolution. Specifically for a student who encountered confusion due to language differences, the shared experience of quarantining during the COVID-19 pandemic afforded her increased motivation, understanding, and resources she could employ when working to resolve confusion.

Environmental or Contextual Factors

The environments and contexts in which students were situated were mentioned as impacting how they responded to confusion. With nineteen participants contributing

perspectives to this category, one element they addressed was how classroom size and structure influenced what actions they took when confused.

Class Characteristics

In lecture courses, participants discussed that it would be difficult to clear up confusion through asking questions, as many professors expressed that they needed to keep moving to cover the material. Three students felt that they would rather ignore confusion in the moment and address it later, for if they did not set aside their immediate concerns, they might miss out on content that would lead them to experience increased confusion. Alternatively, in these large environments, six participants expressed concerns that asking for help in front of peers would make them look "dumb" or would cause them to be "embarrassed," something that, again, was very salient for underrepresented students. These feelings could be combatted if the professor was welcoming and encouraging, like one Ariana had: "If you have a question you don't understand, you won't be so afraid [to ask during class] because he tries to make a connection with his students." In discussion-based classes, participants felt that the increased relationships and interactions led to more comfort with asking questions and having confusions addressed immediately. However, there were concerns voiced by Gianna that these small classes can give rise to "judgmental" students, whereas people may be more understanding in large courses. Therefore, for her, she was not open to asking questions during class time in a small, discussion-based class.

Although the move to online instruction proved difficult and posed many challenges for students and teachers alike, four participants discussed how the shift to remote learning increased ease and accessibility of resources for resolving confusion. Heather and Jeffrey commented on the fact that it was easier to ask questions during online, synchronous class sessions compared to being in-person. Both highlighted the utility of the

chat and how it decreased the pressure and attention associated with raising their hand during class. Jeffrey appreciated the immediacy of professors responding to questions, and felt that he was less concerned about asking "dumb" questions because "you're just a name on a black screen [...] they'll never know what you look like or ever have to run into [them] getting out of class or anything like that." In Heather's situation, the chat helped to relieve concerns about interrupting the lecture or the professor's thoughts, or about introducing topics the professor had already passed on from:

> Through Zoom, for me, it's been a lot easier to still be able to, like, ask questions even after we pass the topic. And you know the teacher is going to see it because it's, like, in the chat. So that's been easier for me because I feel like it also, like, takes off the pressure of, like, having to raise your hand and, like, in the middle of class around everyone and ask 'Oh, hey, can we go back to this one thing.'

The increased ease of asking questions online made, at the very least, these two participants more likely to engage in that action when confused during class. In addition, moving courses online added an additional resource for students: class recordings. Now if they were confused during class time, they could rewatch content and take steps toward resolving confusion through this medium. Another affordance of the online space was its accessibility. Gema, Jeffrey, and Freya reflected that they started attending office hours more to ask questions once these started being held online, in part because they did not have to leave the house or brave walking in the heat. Thus, being in online instruction was an asset for several students, pushing them to engage in actions intended to help them resolve confusions.

As I touched on in the previous section on motivational factors, the online environment was not universally seen as making it easier for students to resolve confusion, with some finding it easier to ignore their confusions rather than attempt to resolve them as they would have in person. When they were motivated to address confusions, Freya

pointed out that seeking help from others was more difficult, that she would be unable to have quick check-ins with neighbors about confusions during class, and she felt more likely to resort to finding resources on her own.

Professor Characteristics

Professor characteristics were another factor participants took into account when considering the choices they made in responding to confusion. If a professor was engaging or kind, students reported being more comfortable asking questions (Erin: If it's a classroom where I feel comfortable because I know that the professor is going to be really nice and explain it thoroughly, then I will [ask during class]. But if it's an intimidating professor, then I won't"). In addition, if professors did not seem to care,

> ...it makes you not want to care about the class, and it also makes you more scared to go talk to him [the professor] because you feel like you're just bothering him and like wasting his time and he doesn't really care, he just has to teach you. (Lily)

The approach a professor took in facilitating a certain classroom climate and communicating messages about themselves and their views of the course seemed to have an important impact on the approach and strategies students employed for resolving confusion.

Peer Characteristics

Peers impacted students, as well, in terms of the choices they made for addressing confusions. If peers were judgmental, competitive, or presented themselves as experts, learners reported feeling reticent to ask questions. Gender and representation could lead to an expression of imposter syndrome, which seemed to add to this reticence to make confusion explicit or to ask for help during class, as learners did not want to look dumb, especially when others seemed to be comprehending the information. As the physical

classroom environment and professors play a role in shaping students' responses to confusion, a classroom community and the peers that make it up are influential, as well.

Situational Factors

Just as students do not learn in a vacuum, they also do not live in a vacuum. For learners who take on additional responsibilities outside of school, like Jasper who worked 45 hours per week, circumstances will impact how they resolve confusion. Whereas Jasper more typically relied on his friends because he could not go to office hours due to his time constraints, he would schedule time to meet with his professors if his friends were unable to help successfully. Time was rather salient to Jasper who took it into account when considering how much time he had between confusion recognition and when a given assignment or assessment may be due: "If I'm studying for an exam and the exam's three days away, I'll go to the professor." Conversely, some participants expressed that they were likely to reach out to friends or peers in their courses for help that they needed soon in time, unless they had previous knowledge that their TAs or professors were expedient in their responses.

Cultural or Personal Factors

The personal and cultural identities students brought with them to the learning experience also shaped how they responded to confusion. For example, students with external familial pressure to be successful considered "that I'm paying for this education and the fact that if I don't graduate, my parents are going to be very disappointed, all of these external motivators make...fuel into my intrinsic motivation to get those confusions figured out" (Selena). Another consideration of students was their cultural norms, as Zan explained:

> I feel not comfortable to express my confusion with Professor. Part--partially I think it's also probably because it's, like, from the Asian culture that [...] you should not confronting your teachers and your parents and I feel like maybe it's just something I did wrong or I didn't think correctly.

Although not reaching out for help may be perceived by instructors as a maladaptive behavior, it is important to consider the variety of identity and culture-related factors learners bring with them into academic environments that shape how they perceive and respond to experiences like confusion. Now that we have discussed the factors that may impact what actions students reported when faced with confusion, I will describe the outcomes of these actions.

WHAT IS THE RESULT OF CONFUSION?

Participants considered whether confusion was positive or negative, and they deliberated about whether the result of confusion was beneficial or not. For them, the outcome of confusion depended on whether they were able to resolve it or not.

Unresolved

Unresolved confusion was helpful for certain individuals in that it led them to alter their future behaviors. For example, in Lily's case:

> It took more, like, not just confusion, but then like failure to then be like, 'Oh, I need to change what I'm doing, I need to go to office hours and get help, I need to actually prepare harder.' [...] So it took, like, not being successful for me to change how I study.

Experiencing failure as a result of not addressing confusion created an impetus for ensuring that future meaningful learning strategies were employed to resolve confusion. Unresolved confusion was particularly negative when the participant did not know it was unresolved:

> I found that when I didn't give myself enough time to learn and I was like...I kind of glossed over things and tried to tell myself I understood it, I found that on exams or whatever, I had to apply that knowledge, like, I was more confused. (Saachi)

For others, unresolved confusion was relatively neutral, as in discussions about ideological differences.

Three participants related their comments about unresolved confusion to exams or assessments, noting that it was usually "fine," or that they would have to accept that "I still don't understand, and there was, like, one question on the final and I was like, 'Well, I don't know it'" (Jorge). It appeared that learners accepted moving on from confusion once they determined they would not be assessed on what was confusing them, at least for some time. There was less obligation to solve confusion in classes participants did not care about or were not for their major. However, participants did recognize that too much confusion was bad in that it would lead one to be so "bogged down" that they could not understand new incoming content. In addition, not resolving confusion would lead to more confusion, anxiety, and frustration over time (Jorge: "[unresolved confusion] starts to lead to frustration, and then eventually just lead to, like, blocking, and it can seem, like, well...I'm done"). There was a general recognition among the participants that if you "never do anything about [your confusion], that's not gonna help you learn at all" (Mabel). Some of the participants recognized that their ultimate goal was not to learn all the content, likely an impossible task. Rather, they typically resolved confusion when they felt it would be necessary in order to meet their goals.

Resolved

Resolved confusion was seen as a positive part of the learning process. Reiterating a concept from the first category, participants highlighted that resolving confusion, specifically through effortful processes and strategies, led to deep learning and "better

results down the line" (Saachi). Participants stated that it was satisfying to be able to understand complicated topics, and they saw the process of addressing confusion as leading to engaging in meaningful learning strategies that would help to synthesize material and result in retention of the concepts.

Chapter 5: Study 2 Rationale and Method

The findings from the focus groups provided a foundation for understanding how learners conceptualize and react to confusion through retrospective means. With this, I saw it as important to use a second study to consider what confusion looked like for students in real-time. It was my intention to use these findings to create a process model of learners' experiences of confusion.

After gleaning insights about how students respond to confusion in academic contexts, primarily from in-person instruction, I wanted to validate and test these findings in online courses. During the Fall 2017 semester, roughly 58% of all undergraduate students enrolled in higher-education institutions in the United States took at least some of their courses online (Ginder et al., 2019). Throughout the COVID-19 pandemic, a large-scale shift to remote learning occurred that may result in wider adoption of online classes at colleges and universities in the future (Lockee, 2021). In these spaces, learners are engaged in an individual process, where social resources and supports are not as common or familiar as students have experienced in in-person classrooms. Based on some of the initial findings from the last focus groups I conducted in Study 1, it seemed more likely for students in online classes to ignore their confusions and/or not seek help from others than if they were learning in a physical classroom.

In online classes, it is much more difficult for an instructor to assess levels of confusion than in in-person learning environments where an instructor can note physical or verbal cues indicating a student is confused and adapt content or instruction appropriately (Arguel et al., 2017). Especially in online environments that lack interactivity, immediate feedback, and timely support or scaffolding, learners who experience confusion are likely to fall into feelings of frustration and disengagement that

lead them to give up on the session or course at hand (Arguel et al., 2017; Yang et al., 2016). Given that online classes have now been a part of many students' undergraduate experiences, a trend likely to continue, this is an important environment in which to investigate confusion. To address this gap, I observed online class sessions offered by the same university used in Study 1 and conducted interviews with learners, both those who indicated or explicitly expressed they were confused during the class meeting or when interacting with course material outside of the session, and those who did not. My research questions were as follows:

1. How is confusion experienced in an online course?
2. What factors play a role in determining what path students take when feeling confused during remote learning?

PILOT STUDY

In order to establish an effective protocol, I conducted a pilot study in the summer semester prior to the semester when I gathered the main data for Study 2. After contacting three instructors, one agreed to allow me access to their course, whose content covered topics of human sexuality. Enrolling, 101 students, the course was conducted asynchronously, so rather than attending a class meeting as I would in a synchronous course, I reviewed material on my own. With the lack of coordinated class times, participant recruitment occurred through emails I sent to students at three time points in the semester, once close to the beginning, once near an exam, and once before the conclusion of the course. I asked students to reflect on experiences of confusion occurring within a week of responding to the survey, though they could do so at any point during the semester.

Of the 17 students who responded to the survey, six volunteered to be interviewed. Participants included four women and two men aged 19 to 24 years old. They self-identified as Asian/Asian-American (4), White/European American (1), and Multi-Ethnic (1). The interviews were conducted over Zoom and lasted between 20 to 30 minutes.

The pilot study proved integral in preparing for the second study. Learning how students responded to these questions allowed for revision and better preparation for asking probing follow-up questions. In addition, given the small proportion of responses, I believed it would be worthwhile to ask the course instructors to send surveys to garner more feedback. Finally, I found that asynchronous courses may not be the most effective environment for studying confusion processes soon after recognition. The particular confusions students reported made it difficult to conduct stimulated recall, in part, because there was not a singular class session or targeted set of materials to draw from. Learners were moving through the course at different paces, and thus, I had to rely more on student recounts of their experiences, rather than being able to guide them through their recall. Asynchronous courses may be worthwhile environments for capturing experiences of confusion occurring outside of class time (e.g., recognizing during homework completion or studying). When working to capture students' recollections soon after confusion recognition or experience, synchronous classes seemed a better venue, especially as they would provide a smaller scope of time upon which learners can reflect and respond. With these lessons in mind, I sought synchronous courses sites for my second study, whose methods I describe below.

METHOD OF STUDY 2

After establishing an initial understanding of students' experiences of confusion, I aimed to validate and extend these findings by moving closer, temporally, to learners'

recollections of confusion. I conducted classroom observations of six courses conducted synchronously, online. Students had the opportunity to complete a survey curating information about their time experiencing, or not experiencing, confusion in the given class session, and then could volunteer to participate in a one-on-one interview to expand upon these responses. Due to the COVID-19 pandemic, all class meetings, observations, and interviews were conducted online. Again, I used grounded theory as the framework for my approach as it provided me with flexibility for revising my questions over the course of the interviews and allowed for building a local theory out of the data.

Interviews

The focus groups in Study 1 proved to be beneficial for constructing an understanding of how students generally think about and move through confusion. This structure allowed for participants to build on one another's experiences, expressing similarities and differences that helped to form an understanding of student confusion. To validate the process proposed by the focus group data, I interviewed individual students in Study 2. This format was most productive as I hoped to delve deeper into learners' processes, asking them to be personal and share vulnerabilities with me. In addition, it was my goal to delve into specific experiences, uncovering details and nuances for a given student's process of confusion. A focus group setting would not have facilitated this level of depth and likely would not have encouraged participants to be as candid as they were when interacting with me individually.

Setting

The setting for this study was the same as in the first. With the university's shift to online instruction, the observed classes and interviews were conducted through Zoom. The

six classes I observed spanned a range of content areas, sizes, and formats. The represented disciplines included statistics, engineering, biology, educational psychology, and undergraduate studies (though this one had a political focus to the course). Courses ranged from ten to roughly 200 students enrolled, and they were taught through discussion, flipped classrooms with time in class devoted to activities, a mix of lecture and activities, and exclusively lecture.

Recruitment

In part, courses were selected through convenience sampling. Through networks and relationships with varying professors and instructors of undergraduates across disciplines, I inquired about their willingness to allow me to observe two class sessions and to send students the survey after each class. I contacted or was put into touch with eleven instructors, with six granting permission, three declining, and two not responding. Of the instructors who agreed to participate, one was a tenure-track professor (a White woman), two were advanced-stage graduate students (both Black women), and two were non-tenure-track faculty members (one Asian woman and the other a White man).

The recruitment of student participants was a completely voluntary process. After a particular class session that I had observed, they were encouraged to fill out a survey (Appendix B) about their experiences during the class session. The last item on the survey asked them if they were willing to participate in an interview. Four of the classes offered no incentives for completion, one course offered extra credit for an assignment, and another included this study as part of the required subject pool study completion for course credit.

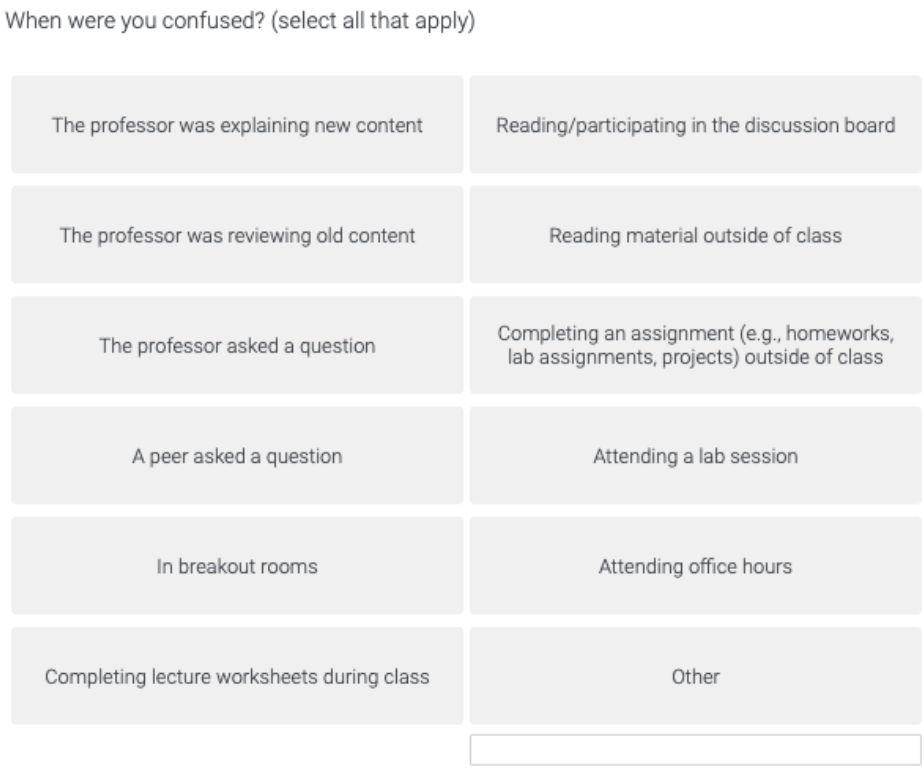
Participants

Of the 232 students who completed the survey, 19 completed interviews with me. The 19 participants for this study were from five classes, as no students volunteered from one course. Two of these students interviewed with me on two occasions, once at the beginning and the other near the end of the course, leading to a total of 21 interview sessions. Participants had an age range of 17 to 41, with a median age of 20 years old. The students spanned across the undergraduate years (6 first-years, 3 sophomores, 3 juniors, 5 seniors) and included a first-year master's student in addition to a non-traditional undergraduate who was returning to the university for a second bachelor's degree. They self-identified as Asian/Asian-American (6), White/European-American (5), Black/African American (3), Hispanic/Latin-American/Chicanx (3), and Multi-Ethnic (2; both identified as White/European-American and Hispanic/Latin-American/Chicanx). Participants self-reported their gender identity as female (9), male (9), and one as non-binary. Of the students, five were the first in their family to attend college and self-reported GPAs ranged from 2.2 to 4.0. The students were majoring in 11 distinct areas.

Procedure

After agreeing to participate in this study, I asked all instructors for access to their course on the university's learning management system. This action was to help with providing access to materials that might be pertinent for stimulated recall (e.g., class recordings, discussion boards) and to allow for survey curation taking into account the unique elements of each course. These distinctions appeared on the question "When were you confused?" (Figure 1) where students could select as many of the different course aspects that had caused them to be confused in or outside of class.

Figure 1: Example Survey Item



Note. Depiction of survey question from the observed statistics course where students could indicate elements of the class that led them to being confused.

Upon construction of the survey, I would send this to the instructor for dissemination after the class session. I determined that it would be most effective for completion purposes if the instructor sent the survey to all students, as they would be more likely to open and respond to a request from their teacher than an unknown researcher. I asked all instructors to send the survey link immediately after the class session, though, due to personal constraints on three occasions, the survey was sent between six and eighteen hours after the class meeting. I provided example language the instructors could use when sending the survey to students, though ultimately allowed them freedom as to

how they would communicate with them. An example of the language sent by an instructor is included below:

> Allison Zengilowski from the Educational Psychology program is conducting research on how students experience confusion in online courses. As soon as you can, please fill out this survey (should take about 5-10 minutes) related to your experience in class today and volunteer to answer some follow-up questions with her if you are able. These reflections will give her valuable feedback on how students learn online and may help you to improve your learning process.

Class Observations

When attending the class sessions, I remained with my camera off and muted so as not to intrude. When students were sent into breakout rooms, I would go with them, silently observing the group to which I was assigned. I took notes of the content being discussed at various time points to serve as a reference for accessing confusing spots during the stimulated recall interviews. In addition, I marked how many students had their cameras on, and kept track of other elements that could prove useful for stimulated recall, including noting those who asked questions and what were those questions, and keeping records of the chat in case these students volunteered to be interviewed. At the end of some of the observations, the instructors introduced me and allowed me to describe the study I was conducting, letting the students know they would be receiving a link to the survey and about interview-related time constraints. It was my thought that the students might be more likely to volunteer for an interview after seeing my face and getting a sense of me. Although I asked all instructors if I could do such an introduction, due to time constraints or lack of remembering, this only came to fruition in five out of the twelve observations.

Survey

The survey asked generally about students' experiences of confusion either in the class session or outside of class within the past week. Participants could be exposed to at most 29 questions, depending on the information they provided, typically requiring five to ten minutes of their time. Primarily, the survey was used as a tool to collect information about the experience of confusion that would allow me to curate materials and prepare for the simulated recall portion of the interview. Students were asked questions including "What were you confused about?," "What led you to feeling confused?" and "What did you do when you felt confused?" If the students agreed to participate in the interview within 48 hours of the class session, they scheduled a time to meet and then finished the survey. However, if students did not want to interview with me, they were directed to additional questions including "Do you feel there are different types of confusion?," Describe the type(s) of confusion," "How do you feel when you are confused?," and "How does your experience (or lack) of confusion relate to your feelings about this course?" These questions were intended to elicit additional information for coding and consideration, information that otherwise I would have acquired through an interview. In-depth analyses of survey responses are reserved for a later manuscript.

Interviews

Interviews were conducted over Zoom and lasted from 12 to 50 minutes, the majority lasting 30 minutes. The sessions were recorded and a transcript was automatically generated. After the conclusion of the interview, I edited and verified the transcripts, providing pseudonyms to protect participant identities.

When participants entered the Zoom room, I conducted small-talk to establish a sense of comfort and rapport (Krueger & Casey, 2015). If students indicated they had

experienced confusion in the survey, I began with the question "Can you recall for me the experience of confusion you wrote about in the survey?" and "How extensive was your confusion?" These questions, repeated from the survey, were asked as a way to ensure confirmability of the data. However, if the participants noted they had not been confused either in the class session or outside of class over the past week, I began with "How has the class been going so far?" and followed up with asking what actions they may have taken to prevent confusion or if they had previously felt confused in the class. Although participants may have reported they did not experience confusion on the survey, there were times during the course of the interview when participants remembered an instance, and we discussed their subsequent experiences.

For the interview protocol itself, I had three primary categories of questions (Appendix C). These first included prompts specific to the experience of confusion, striving to elicit an understanding of the processes with which learners engaged. In this section, I would engage the student in stimulated-recall. Taking direction from the survey and verbal recollection of when or about what the participants indicated they were confused, I would introduce and share my screen to show relevant materials. These sources included video recordings of the class session, questions asked by the instructor, assignment descriptions, lecture slides, and scaffolded notes from the instructor. After sharing these materials during the interview, I would ask questions such as "What was going through your head, what were you thinking?" or "What were you feeling when you saw this?"

After asking follow-up questions unique to the participants and their experiences, I would move on to asking them about their general experience in the online class. These questions were reminiscent of those asked during the focus groups, though focusing primarily on their perceptions of and relationships with peers, professors, and TAs. The

intention in asking these questions was to clarify how students would seek help from others, an important source for resolving confusion, in the fully remote context. Finally, if there was time, I asked participants if they felt there were different types of confusion and if so, to describe what were the distinctions. At the end of the interview, I thanked participants for their time and encouraged them to contact me if they had questions or further contributions to share.

Data Analysis

When coding the interview transcripts, I followed a similar procedure as I did in the first study, following the steps Corbin and Strauss (2008) outlined for grounded theory work.

Theoretical Sampling

Theoretical sampling was an integral part of the interview process. Although I had an established list of questions I had prepared prior to the session, it was imperative to ask unplanned follow-up questions based on participant responses. These were unique to each student, and I used them to reach additional depths and uncover more information than might have been provided when answering the original prompt. After each interview, I wrote a short synthesis of important or new information garnered from the participant.

Coding Process

I engaged in two separate open coding processes. The first involved two rounds exclusively with the transcript data resulting from the questions participants responded to reflecting about the specific instance of confusion. The second process included data from the entire transcript, again, using two rounds of open coding to establish concepts and categories. During each of these, I practiced axial coding, creating hierarchies of

categories, and comparative analysis to distinguish similarities and differences. Finally, I integrated the data and used the results to provide evidence for the creation of a process model of confusion.

Data Trustworthiness

To meet the standards of credibility, I met with another researcher after each round of coding to consider what refinements and further analyses to conduct, also engaging in member checking (Woodruff & Schallert, 2008). Iterations of concepts, categories, and the process model were made during these meetings after consensus discussions. As I mentioned previously, I triangulated data from the surveys and interviews to establish a standard of confirmability. This ensured that recollections were accurate, and the results could be trusted as an credible representation of the participants' experiences (Krefting, 1991; Lincoln & Guba, 1985).

Chapter 6: Study 2 Findings

Having analyzed the data from 21 interview transcripts, I created a model of students' confusion processes. First, I will open this chapter with a general outline of the model before I go into detail about the component parts.

General Explanation of the Model

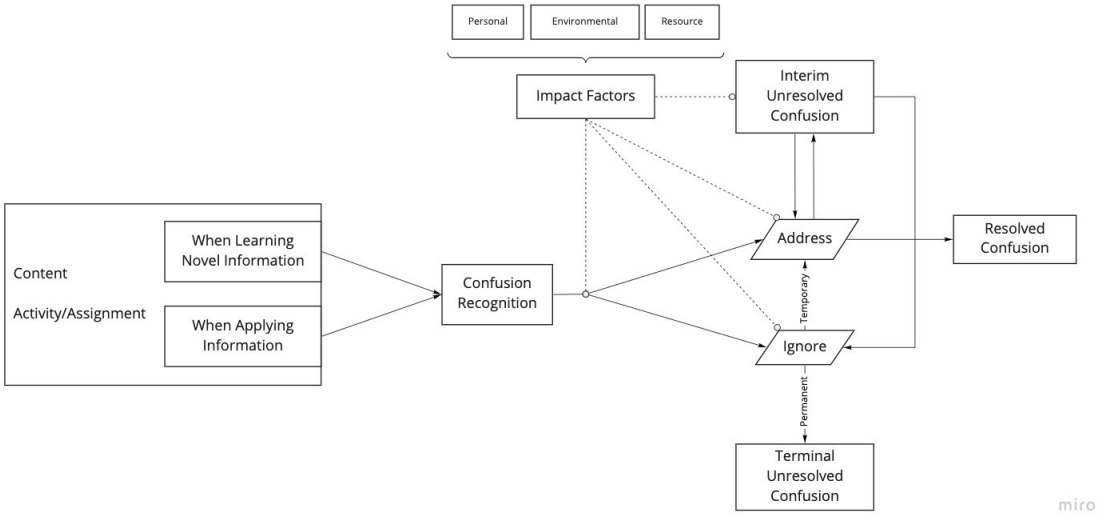
As depicted in Figure 2, the process of confusion begins linearly and can play out circuitously. Although it is certainly possible for learners to have a metacognitive failure and not recognize their confusion, for the purpose of this model, I am depicting the processes for those who make an explicit evaluation that they are confused.

Upon first experiencing a state of being confused by content, an activity, or an assignment when learning new information or during application, students engage in metacognitive monitoring or evaluation, leading to a recognition of confusion. Moving from recognition, learners will decide either to address or ignore their confusion. When students choose to address or ignore their confusion, they take into account factors that ultimately impact what they decide to do. These include perceived resource, personal, and environmental factors. These factors again play a role in determining the actions or decisions students make after they have already chosen to ignore or address their confusion, or when they experience pending unresolved confusion.

When learners choose to ignore their confusion, they may decide to do so permanently, resulting in terminal unresolved confusion, or only to do so temporarily. If opting for the latter, they will, eventually, move to address the confusion. Multiple outcomes may result from attempting to address confusion. Depending on the actions they take, learners may be able to resolve their confusion after a first attempt. If this scenario does not occur, they will move to interim unresolved confusion. Students could

immediately return back to address their confusion, perhaps deciding to try a different tactic or they could decide to ignore the confusion. Learners will engage in a variation of this circuitous process until, either they resolve their confusion or decide to leave it terminally unresolved.

Figure 2: Model of the Processes of Confusion



SOURCES OF CONFUSION

When interviewing participants, I asked them to recall the experiences of confusion about which they had written in the survey, identifying what caused them to be confused. Among these students, confusions arose from content (nine participants) or activities/assignments (six participants; the remaining four did not recount experiences of confusion from the classes I observed). In the following section, I will outline what were these sources of confusion.

Content

During learning, students are tasked with grasping and integrating new ideas into their knowledge base. For three participants, they experienced confusion that was attributable to the fact that they were learning novel concepts. Because this was "the first time [they] saw those types of topics and those types of ideas" (Aalim), they experienced confusion. The novelty of application was another source, with one student reporting being confused watching the professor go through a practice problem based on new content.

Missing information resulted in confusion for students when learning new content. The experiences of missing information were tied in part to the online environment, where students found themselves distracted or taken away from the learning context. In one situation, a participant had to connect with maintenance workers who had arrived at his apartment during class, so he missed a part of the lecture: "by the time I came back, like, [the professor] already kind of explained, like, the core of what we were going over" (Miles). Missing the key parts of the content caused Miles to be confused and resulted in it being difficult to continue learning new content. Another student encountered difficulties keeping up with new content in class and following along with a worksheet provided by the instructor. Alicia found that by focusing on where the instructor was on the worksheet and trying to match his pace, she was not listening to his explanations of the content, resulting in her missing content and ending up confused.

Specific terminology and difficulties with, sometimes assumed, prior knowledge worked together to cause confusion for three participants. When Meilin was preparing for class, engaging with course readings or looking at slides, she would find herself confused by certain terms or definitions. During class time, new terminology hindered learning of content for Hakesh who found himself confused when learning about principal component analysis because he "didn't understand, like, the difference between variance and

covariance, necessarily, because, like, even though they appeared to be very similar terms, they indicated, like, the opposite thing." Alternatively, terminology can lead to confusion when instructors believe students have a certain level of prior knowledge. In a statistics course, Risa, a senior who had not taken math since high school was confused about false positives and true positives. These were terms the professor was using in describing concepts, and due to her confusion about what these indicated, Risa had difficulty learning content from that day's class.

The last content-related confusion was tied to the amount of to-be-learned content. Dean reflected on being confused about a certain topic in class, describing that he felt it was because "it was just, like, a lot of information to digest at once." Being inundated with new content could result in confusion, potentially leading students to feel overwhelmed not only in the class session, but in the course over the long term.

Activity or Assignment

When participants recalled being confused by an activity or assignment, their comments suggested the confusion arose from one of two conditions: not understanding instructions or not remembering/encoding instructions. For four participants, unclear assignment instructions caused confusion. Kassandra noted her confusion stemmed from reading an assignment's requirements, finding that they were "a little bit vague and so I was just confused as to, you know, exactly what direction I needed to go with it." Other sources were related to delving into an activity without understanding the instructions, causing confusion about how to engage or why they were engaging with the material.

Lastly, class activities were the primary environment where students were confused because of a lack of remembering or encoding the instructions. One source was related to learning class norms, being confused about "deliverables or small daily things" (Marisol)

they were expected to remember. In another instance, not encoding activity instructions caused Joel to be confused about a class activity, which he noticed when he was put into a breakout room to begin work with others.

CONFUSION RECOGNITION

Having described the sources of confusion, what participants were confused about, I will next discuss when students recognized that they had become confused. Corroborating the findings of Study 1, participants indicated that the two situations resulting in confusion recognition were when they were in the process of learning novel information or applying information.

When Learning Novel Information

The participants indicated that they recognized confusion when they were learning new material, either inside or outside of class. When reviewing course materials (e.g., readings, lecture slides) prior to class, Meilin indicated that she would oftentimes find herself confused. She echoed very similar sentiments to Zan from the first study, as she would find herself confused over definitions stemming from her native language not being English:

> ...there was like a definition that is just not that clear. And I will get confused. And I guess you can tell, like, I'm not a native English speaker. So, like, sometimes I'll just go, 'Does this mean what I think it means?' You know, like, 'Does it means this? Or does it have another meaning that I don't understand?'

Experiencing uncertainty and doubt about her interpretations of new information, Meilin recognized confusion when learning on her own prior to class. Three other participants indicated they were most likely to recognize confusion during class time. In this environment, the students expressed that the pace of a course that "keeps going, whether

or not, regardless of me" (Hakesh) led them to recognize their confusion, specifically as they could not address it immediately. In Julián's experience, he added that he would recognize confusion during class when it was "hard for me to focus, like, pay attention to what's going on." In class, students may recognize confusion because the class is continuing and elements of it are not making sense, or they may start to tune out, providing a recognition that they have reached an impasse in their learning.

When Applying Information

When participants were placed into situations where their knowledge was tested, they were likely to recognize confusion. Kamilah recognized a logistical confusion when she was beginning to write an essay, but it was only upon starting that process that she recognized her confusion. During class, Joaquin was given a prompt to reflect on and answer on the spot. Had he been able to listen to another's response or if the question had been communicated through lecture with the instructor merely delivering the information (asking the question rhetorically and then answering it immediately without student input), he might not have come to recognize the breakdown. However, the application and "test," prompted him to realize "that's why I was confused, I don't know how to answer that question. Maybe I'm not perceiving it in the way that [the instructor] wants me to perceive it." When coding these responses, a commonality emerged in this theme: participants were recognizing confusion when experiencing a metacognitive breakdown.

Participants voiced that, oftentimes, they recognized their metacognitive breakdown when applying information on their own. In Raneem's case, she reported:

> ...there's been a lot of times where I don't understand my fundamentals, but I don't realize I don't understand them. And so I'll be moving on to more complex problems. And I won't know where to start. And then I have to...I realize that I need to build up that foundation first.

Expanding on this idea, one participant indicated that it was during lectures where she developed a sense of competence and confidence in understanding the material, only to find out during application that she had made a misjudgment:

> ...during the lectures, um...like, I kinda follow through and I'm like, 'Okay, I kind of understand this.' But then, like, when we get to the homeworks, and we have to like code and do that stuff...And it's, like, very different and difficult to understand. (Jada)

Without testing their knowledge, learners may find their confusion goes unrecognized, especially "if the test doesn't have this question on it, I would think 'Oh, of course I get it right'" (Meilin). Homeworks and tests enabled metacognitive breakdowns when learners tried to apply their knowledge and experiences.

Meilin recalled a different scenario that led to confusion recognition. For her, it was not until she received her exam back and found that she had answered a question wrong, one she believed to be a correct response, that she recognized she had confusions associated with the material. In this case, she had integrated information incorrectly, recalled what she knew, only to find out from feedback that her knowledge was erroneous. As evidenced by Meilin's situation, feedback from situations when students are asked to apply information could support and lead to confusion recognition, potentially facilitating deeper learning than if the confusion had gone unrecognized (Quinton & Smallbone, 2010). Thus, teachers play a role in the confusion recognition process in addition to the students themselves.

BEHAVIORS IN RESPONSE TO CONFUSION

When learners respond to recognized confusion, they are likely to make a decision between addressing and ignoring their confusion. Here, I will describe the varying actions (or inactions) participants expressed they engaged in when responding to confusion.

Address

Learners deciding to strive for a resolution of their confusion engaged in one or multiple forms of "addressing" or taking actions. Participants voiced experiences related to them determining the source of the confusion, then making a plan for subsequent actions, seeking out sources along the way. I will conclude this section with a discussion of the "processes" some participants explained, where they outlined how addressing their confusion was often a repetitive, sometimes circuitous process rather than always a linear one.

Determine Source

The first step in addressing confusion for two participants was to determine the source of their confusion. "I just kind of sit with the confusion for a second, I kind of like to speculate a little, like, I'm like, 'Okay, well, I'm confused. Let's address why, like, let's think through why I'm confused'" (Mariah). From a metacognitive standpoint, this action is highly adaptive as it can allow learners to determine the subsequent action(s) to take in service of resolving the confusion.

Make Plan

Before delving into a subsequent action, three participants expressed that they would make a plan about how to resolve their confusion. Doing so allowed Mariah to determine "which resource I can then use to get to understanding." Beginning to make a plan could also help participants decide if it was worth resolving the confusion at all, if the source of confusion was something "I actually, like, really needed to know [...], or if it was just, like, something to go more in-depth" (Risa). Beginning to seek out sources and resources aided Risa in making a determination about how to address her confusion, whether she would decide to take subsequent actions or choose to ignore it.

Seek Sources

Participants noted a variety of sources they accessed in order to address their confusions. These fell into two categories of self and others, where "self" resources are sources learners accessed on their own and through an individual process. "Others" refers to people, primarily peers, TAs, and professors, being accessed both in-class and out-of-class to aid in confusion resolution.

When participants saw themselves as the best resource for confusion resolution, they tended to turn online or to class materials. When Joaquin was confused, he would simply, "Google that up," primarily because he felt confusion was his responsibility to resolve, so he did not want to ask others for help. Julián also turned to Google when facing a confusion during class time. After hearing his professor contradict information from the class reading, he needed another source to confirm the correct answer.

Four participants mentioned using class resources to address their confusion. A resource available to learners in online classes that differed from those in-person were recorded lectures. Risa and Porter mentioned turning to these as a means of addressing their confusion, finding that "after watching [the class recording] again, I'm like, 'Oh, okay, that makes sense'" (Risa). Porter provided additional details for his experience, mentioning that he would screenshot slides he felt provided information to help with addressing his confusion after class, using those as markers for where to return in the lecture recording. Other resources participants used to address their confusions were course readings or completing example problems provided by the instructor.

There were another three participants who indicated that they used a mixture of online and course resources to work toward resolving their confusion. Two of these students discussed how they would return to the lecture video or the class slides, supplementing those with information from Google. In another case, Alicia would wait for

lab handouts and exercises, combining those resources with Googling, finding that she would return to address her confusion "during lab and in the next homework. And then I'll do, like, most of my learning...that's where, like, where it all clicks." Students were resourceful when confused, seeking out various types of resources to begin addressing and attempting to resolve their impasses.

As discussed in the focus groups, participants saw others as a productive resource in the process of addressing their confusions. Ten students mentioned their experiences seeking help in-class and out-of-class. During class time, two participants recalled relying on their peers for help during breakout room sessions. Listening to explanations, hearing "what others are saying, that...that helps you, like, grasp [it]" (Joaquin). Given the remote nature of their learning experiences, breakout rooms were the primary place where students connected with their peers for help during class time. Otherwise, participants relied on their instructors for help. They would either ask immediately "in the chat, or if the professor's, you know, allows us to just unmute and...and say something, then in that context" (Kassandra), or they might choose to wait until after class, seeking out their professor or their TA for assistance.

Outside of class time, four participants indicated that they would choose to email their TA or professor about their confusion. Another option was to turn to the class GroupMe, where Kamilah, oftentimes, would only look at the chat to see if a question related to her confusion was asked, rather than ask for help directly herself. Raneem took a more direct approach by voicing her questions in this space, though sometimes she found this mode unsuccessful in resolving confusion as she might not receive any response, or receive an explanation that still did not clear things up and end up feeling like it was "too much to ask again." As evidenced by Raneem's situation, addressing confusion does not

always lead to resolution. Rather, students may have to go through a process before they would see the confusion as resolved.

Process

Nine participants discussed having a process they move through when addressing confusion, highlighting that they often need to seek assistance from multiple sources before they resolve confusion successfully. In the situations I highlight in this section, the learners described cycling between addressing and holding their confusion unresolved temporarily, hoping to reach an eventual resolution. However, it is possible that at the end of their processes or between steps, they would be impacted by certain factors or choose to ignore their interim unresolved confusions. A step-by-step delineation of all participants' processes is listed below in Table 2.

Table 2: Participant Processes Addressing Confusion

Participant	Source 1	Source 2	Source 3	Source 4
Mariah	Course materials	Online sources	Professor	--
Marisol	Course materials	Online sources	Professor/TA	--
Raneem	Course materials	Online sources	Course materials	Professor
Jada	Course materials	Professor/TA	Online sources	--
Meilin	Course materials	Professor	--	--
Miles	Course materials	Professor	--	--
Risa	Self	Peers	Professor	--
Porter	Online sources	Professor/peers	--	--
Aalim	TA	Online sources	Course materials	--

At least six of the participants began their confusion resolution process by turning to course materials, be it readings, lecture slides, lecture recordings, or notes from class. One student, Risa, indicated they would first "go back and figure [the confusion] out myself," making this depiction unclear if they would use course, online materials, or a

mixture at this step. Three of these participants then turned to online sources, with two ending the process seeking help from their professor or a TA. All but one participant began the process of addressing confusion by working to resolve the confusion themselves, and professors or TAs were the last recourse for seven of the nine participants. These data are in line with findings from Study 1 and of another study focusing on help-seeking processes of undergraduate students (Payne et al., 2021). One end result for students moving through these processes was resolved confusion, as with Aalim who reported, "usually from those three steps, I usually underst--get my confusion...like, goes to no confusion at all because I've gone to three resources." If unresolved, learners stated they may choose to ignore the confusion permanently, leading to terminal unresolved confusion.

A difference between participants' experiences expressed in Study 1 and those in Study 2 is tied to seeing peers as a source for addressing confusion. In Study 1, peers were frequently included as a resource and part of the help-seeking process for those learning in-person before the pandemic. Participants in the focus groups that occurred during the shift to remote learning mentioned that they did have relationships established, though they indicated that it was difficult to continue to engage with their peers as they had previously. The full manifestation of those differences is clear in Study 2, where participants did not highlight peers as a central or frequent resource in addressing confusion. Only two students identified peers as sources in their processes, with one indicating they would only reach out to classmates "if I'm friends with somebody" (Porter). Given the nature of remote instruction and the lack of direct interaction with peers, it may be that learners are finding it difficult to make connections and form relationships, making them less likely to engage with their peers when confused compared to during in-person instruction.

Ignore

The other behavior learners may choose to engage in following their affective judgment and recognition of being confused is to ignore their confusion. As in Study 1, participants noted that ignoring confusion took on one of two forms: temporary or permanent.

Temporary

When participants ignored confusion temporarily, they indicated that they had an intent to address the issue at a later point in time. This frequently occurred during lectures, with students noting that the professor "was still moving on" (Casey). This was typically an adaptive response where learners would "just keep listening and try to, like, get the rest of it. And then go back at some point in the future to, like, probably look it up or something" (Hakesh). Rather than work to resolve their confusion immediately, temporarily ignoring it could help some students not lose out on additional content that could compound their difficulties in understanding the material.

Temporarily ignoring confusion also came in the form of tuning out. In contrast to the participants who would compartmentalize their confusion as a means to continue learning during class, others found their confusion overwhelming. Again occurring primarily during class, when confused, Aalim shared that "I just, like, don't pay attention at that point." Providing further evidence for findings from Study 1, tuning out was described as a protective measure by Bojing who, after recognizing confusion, would be "not super focused on the subject matter at hand. I guess I was kind of checking out a little bit, just to, like, re-collect myself." Ignoring confusion temporarily, specifically during class, may be beneficial for learners as it can allow them to avoid missing out on understanding additional material from the session.

Permanent

In Study 1, participants described tuning out as a temporary process, where they would make deliberate decisions to return to address their confusion. However, in Study 2, Alicia expressed that her tuning out behaviors were more likely to lead to permanent ignoring and terminal unresolved confusion:

> Sometimes I will just zone out because I'm like it--like, the cost energy, like, benefit analysis of, like, me paying attention and trying to figure out what [the professor] just did when it doesn't really matter to me in terms of, like, what I'm going to need for my homework or lab. I'll just be like, 'You know what, it's time to take, like, a snack break,' and then I do.

What Alicia's experience indicated is that she made a judgment about the necessity of resolving confusion in relation to performance goals. If she had determined the confusion would hinder her ability to complete course assignments, perhaps she would have been more likely to ignore the confusion only temporarily.

Permanently ignoring confusion may not lead to learning, but for two participants, that was not a chosen outcome. Students may consider a cost analysis when determining whether or not to ignore their confusion. In line with performance goals, Risa felt that since "I understood how to do most of the lab and some of the homework, I'll be fine. And [I] decided not to go back [to address the confusion], which is probably dumb. But I decided not to go back." Her inclusion of the phrase "I'll be fine" suggested that Risa felt her confusion was not so debilitating as to impede her ability to receive an acceptable grade on her assignments. Given that her goal was not to master all of the material, permanently ignoring her confusion served her course goals and available time more effectively than addressing the confusion would.

For other students, issues of accessibility resulted in a decision to ignore their confusions permanently. Marisol shared that, sometimes, she would not

> ...buy, like the new edition of the textbook [...] And it's not like I have the resources to go and buy like a $90 textbook every year because the professor provides--says you have to [have the] 17th edition, 18th, 19th. So, sometimes I've just kind of accepted that I'm going to be confused during the exam for specific cases or specific, like, parts of a lecture. And [...] I just accept that I'm not gonna understand it and try my best when I get there.

Financial burdens placed on students can lead them to have to make decisions about their confusions. In Marisol's case, she coped with this situation by ignoring confusions that may have arisen by not having access to the textbook, hoping she could understand the content enough to perform well on assessments. If instructors make course content openly accessible to all students, they may be able to prevent such learners from needing to expend extra effort to seek out sources to resolve their confusions and/or from feeling they must permanently ignore their confusions.

FACTORS IMPACTING RESPONSES TO CONFUSION

When learners make decisions about what they will do in response to confusion, they incorporate various factors into their appraisals. All participants highlighted that these played a role in their process of confusion, with 17 identifying personal factors, 19 discussing factors related to the resources from which they might access, and 13 discussing environmental factors. With these factors being omnipresent, not necessarily a stage that learners pass through, I have depicted them with a dotted line ending in a small nexus circle. Participants voiced taking these into consideration before deciding to address or ignore the confusion, and the factors also had impacts on what actions participants chose to take when addressing, ignoring, or in interim unresolved confusion.

Personal Factors

Factors that were tied to participants themselves and related to their individual lives or personal experiences fell into the overarching category of "personal factors." These included the goals learners had for the class and for their futures, their personal identities, self-conceptions, affect, interest, previous experiences, and the type of question they had or confusion they faced.

Goals

The goals participants expressed as impacting their decisions of responding to confusion were related to their performance and to their differing futures. Two students voiced what I interpreted to be performance goals that had influenced them to choose to ignore their confusion, specifically if they felt it would not harm their overall grade in the class. Both participants indicated time also interacted in this space, with Casey finding that "as things started piling up [...], I would be like, 'Oh, you know what, maybe I don't need to know that one.' And I would just, like, let something go." Rather than being explicitly pressed for time as Casey was, Risa's recollection of her experience appeared to indicate a focus on being strategic with her time, finding that "it may be a waste of time to understand this when I already understand, like, the assignments, which is what is important, you know, to get the grade." For some students, taking the time and effort to resolve their confusion was not necessary for their course goals, and led them to choose to ignore the confusion permanently rather than to address it.

Although sharing similar course goals, being motivated by course performance, other participants expressed this as motivating them toward deciding to address their confusions. For example, Jada stated,

> ...the type of person who my grades are, like, really important to me. So, like, in order to get those good grades, I need to understand the class and not let it be

> something that, like, my confusion...like, I use as an excuse to not pay attention and, like, keep working towards [resolving] it.

Conversely, Meilin seemed performance-avoidance oriented when speaking about her decision to address a confusion: "I want to get this, like, right. So, like, I can understand it. So I wouldn't get it wrong the next time. Because my score couldn't afford another not that good test." Thus, participants' performance goals seemed to impact their decisions about how to respond to confusion, though they showed that these goals could result in a determination of either addressing or ignoring the confusion as most appropriate for their circumstances.

Learners' future goals could also impact how they decided to respond to an experience of confusion. Participants primarily voiced their decisions to address confusion as being related to the value for their future careers. When I asked Raneem to expand on why she chose not to ignore the confusion from her engineering class, she responded:

> Well, this is my first year, and it's the introduction to computing. I'm learning all the basics of what I'm going to use in the future. And it's like a building, if you have a weak foundation, it's gonna fall over soon enough after you keep building on it. [...] Because at the end of the day, my long-term future goal is to be an electrical engineer. And how can I do my job if I don't know what I'm doing? Like, if I'm confused about something and I don't resolve that, or work to resolve that?

In courses directly tied to their possible future selves, participants shared an understanding that they "have to understand these topics. I can't just skim over these topics" (Aalim). Conversely, for students taking classes outside of what they envisioned as their career or future goals, they seemed more open to ignoring their confusions:

> If I'm confused about something [in a humanities course], I just...I'm prioritizing chemistry and biology because right now, my career goal is just to become...to go to med school. And I feel like I need to get, like, a good GPA on my, like, my sciences and whatever. [...] And for [humanities course], like, it's not the priority, it's not as high, cause it's, like, not my main classes [...] it's just, like, a prerequisite

> for freshmen. So it's just, like, my--my--my [humanities] class, it's not as of high importance. (Joaquin)

Specifically at a university where students apply to be accepted to a specific major or college prior to attending, domain identity and future goals seemed especially salient. As evidenced in the participants' experiences, these future goals could impact their decision to address confusion, more so in domain-specific classes, and could be a justification they used for ignoring confusions in classes unrelated to their imagined futures.

Identity

Elements of learners' identities seemed to impact their responses to confusion. One participant, a first-generation college student, reflected on the connections between this part of herself and how she addressed confusion. Ultimately, her identity influenced the types of resources to which she would turn:

> Kids that were forced to grow up faster typically don't ask for help just because, like, that's how you grew up. And, I'm a first-generation college student, and my parents, like, don't know English. So I grew up translating for them. And it was always, like, if...if I couldn't figure something out, I really couldn't ask anybody because, like, my parents didn't know, I didn't have older siblings; it was just kind of, like, something I had to do for myself. So I think that mentality has evolved with me into college. [...] So I would just, like, look for whatever resources I could instead of reaching out to, like, a professor or something. (Risa)

Growing up needing to resolve confusions or questions on her own seemed to have influenced the types of resources Risa decided to access to resolve a confusion. She seemed to have developed a keen strength in being able to rely on herself for resolution, seeking out resources that could support addressing confusions on her own.

Another identity a participant brought with them to the learning experience was having Attention-Deficit/Hyperactivity Disorder (ADHD). On "bad ADHD days" or times in-class when she was not on her medication, Mariah would find herself temporarily

ignoring confusion by procrastinating: “I’m going to play on my phone, like, this will make me happy that I’m not--I’ve like--I can understand this. This will bring me some serotonin. I will get away from my frustration.” In contrast, on days where she felt her ADHD was manageable, she would find herself taking steps to address confusion, thinking to herself, “this is okay. Let’s sit through it and understand why [I’m confused].” In Mariah’s case, her ADHD could differentially impact whether she would choose to address confusion or ignore it.

Self-Conception

Although potentially tied to their identities, I coded participant responses as being related to “self-conception” if these reflected how participants saw themselves versus an identity they carry with them. For example, Joel reported himself to be “a pretty, like, vocal person, I don’t really care what others think. Or at least I’m pretty good at not caring about what others think. Um, if I have a question, I’ll ask [during class].” In this case, Joel’s consideration of himself as being “vocal” and unaffected by potential judgments from peers impacted his decision about how to respond to a confusion experienced during class. He felt comfortable asking questions during class time and would rely on this tactic as a means of addressing his confusion.

Affect or Affective Judgment

Responses in this category related either to emotions participants reported feeling after recognizing confusion or to an affective judgment they made about their options for responding to confusion. Affective judgments are composed of emotional reactions and an evaluation (Northoff et al., 2006). When Casey was determining how to respond to being confused, they made an affective judgment, finding that “ignoring [the confusion] is less

anxiety inducing." This differed from Alicia's response, which was related to her affect. Although she also planned to ignore confusion, she was impacted by her feelings of frustration, finding she "wanted a break from whatever the hell was going on that day." Frustration could also be a catalyst for addressing confusion (Payne et al., 2021). In Joaquin's case, frustration impacted his decision to address, and also how to address his confusion. During an instance when confused in chemistry, he recalled feeling that "I need a tutor. Like, I emailed my tutor, like, 'I need help. I need help in this and that,' because it's, like, an extreme frustration." This differed from his experience being confused in the humanities course where he decided to ignore the confusion because "it wasn't an extreme frustration." Even though Alicia and Joaquin both experienced frustration, they showed different responses to the emotion, indicating multiple impact factors likely interact when determining how to respond to confusion.

Interest

Participants' interest in a class or a given topic could impact how they decide to respond to confusion. In Kamilah's case, she was eager to address any confusion, finding "if I really like the class, I'm going to put in more effort [...] and I'm going to make sure that I eliminate any confusion." For others like Raneem and Jada, they expressed that choosing to address their confusion was, in part, because they wanted to learn: "I'm here to learn, I enjoy learning even if I'm...if I struggle with it, sometimes I like it. I'm curious. So I have an interest in it. I want to know" (Raneem). In the case of these two students, interest and curiosity in the content influenced their decision to address confusion rather than ignoring it. Miles provided a distinction of how interest played a role in his decision-making process, describing how it interacted with performance goals:

> For example, the [principal component analysis] stuff, [professor's name] explicitly said that he's not going to, like, test us over it or anything. So I guess if I was not interested in the class, I wouldn't even, like, worry about it. But I guess since I am more interested in it, I use that, like, the confusion, kind of motivated me to, like, look over it, like, when I have free time. Versus [...] in anthropology where the teacher's like, 'Oh, yeah, I'm not gonna test you guys over this, but here's, like, this one difficult concept,' and I was confused about it, I just kind of, like, ignored it.

Here, Miles found confusion to be a motivating factor, with his interest in a class prompting him to address his confusion. Although not explicitly discussed, it appeared that participants' interest could be related to having a mastery approach, where students find themselves wanting to learn more as a result of their confusion.

Previous Experiences

For the nine participants who discussed previous experiences, a pattern emerged. Those who had had positive experiences stemming from their response to confusion would continue to employ that behavior, whereas those who had had negative experiences tended to adapt when later confused. When asking about Bojing's established process for addressing confusion, he reported, "it's just what I've always done when I've been confused in class [...] it seems to work out okay for me in all the other classes I've taken." Noting that his processes were not domain or course-specific, the fact that he had generally found success with his strategies in the past led him to engage in them in future instances of confusion.

For those participants who indicated that their previous experiences had impacted them in ways that resulted in a change in response to confusion, their descriptions were either affect or utility-related. When Risa chose to address her confusion, she reflected that she would "not ask questions. I usually try to figure it out for myself first, just because...I don't know. I've had experiences in the past where I ask something, and I kind of just feel

dumb for asking it." Wanting to avoid these feelings of being perceived as "dumb," Risa adjusted her response to be, first, that she would work to address confusion on her own. Meanwhile, when considering why he would ask his professors over TAs for help, Porter felt

> ...the teacher would 100% know how to explain it. When I've had experiences with, like, a math class before, where I'd go into, like, a TA session, and they'd be, like, 'Uh, I kind of know how to do this.' And then I would just be, like...halfway learned how to know, like, what I'm doing.

Porter's previous experiences made him carry a belief that TAs would not be the most effective resource for resolving confusions. As a result, when addressing his confusions, his experiences influenced him to seek help from professors rather than TAs.

Type of Question or Confusion

The type of confusion or question they had in response to confusion played a role in how participants decided to progress in the process of confusion. If the confusion was

> ...inhibiting me from doing work or somehow progressing, then that would stay in my head. So, like, I would approach the problem until it's cleared up. [...] But if it's not something that I see an immediate need to apply, then I would probably, like, put it off. (Hakesh)

For Hakesh, encompassing confusion propelled him to address his confusion immediately, whereas for confusion that was not so pervasive, he might choose to ignore it temporarily. This was not a universal experience, as Alicia found herself confused during class where she could not continue following the coding demonstration due to her confusion. "So I was just, like, 'Well, I can't do that anymore. So I just had to kind of watch him." Although Hakesh's and Alicia's confusions were similar in that they were debilitating, Alicia

determined that it would be most beneficial to ignore the confusion for the moment, whereas Hakesh found it advantageous to take steps toward addressing.

The source of confusion also impacted how participants decided to proceed. In describing an experience where confusion was a result of being distracted, Risa determined that her last resort in addressing her confusion would be to ask the professor for assistance:

> So I just felt, like, it was better for me to go back instead later, because I know he records the lectures. And I felt like the concept may have not been too difficult to understand, it was just because my attention wasn't there.

Compounded with feeling that the type of confusion was resolvable, the fact that her confusion was a result of not being fully attentive when learning new information played a role in Risa determining she would prefer to start her resolution process on her own, rather than asking for help from the professor.

One type of confusion that led to differing behaviors by the participants were logistical ones. These were questions related to "when things are due, or like technical aspects of the class," (Alicia) or "formatting, if you have to write like a paper or something [...] do we do MLA or how do [the professors] want citations" (Dean). Alicia believed these questions were best directed to professors, whereas Dean preferred to write them in the class GroupMe for peers to answer. Part of Dean's reasoning for seeking out help from his peers in addressing his confusion was that "asking the group is probably easier, especially to clarify for other students that might be asking the same thing." His choice of the word "easier" may indicate that contacting or asking questions of a professor seemed more burdensome than sending a short question through a chat app. However, he also saw that asking questions in this public format was productive in helping other students who may be struggling with similar confusions.

Resource Factors

When choosing to address confusions, participants made decisions about what resources they would access. Factors impacting their decisions about what resource to access included: (a) were they the best resource given participants' needs and constraints; (b) overall perceptions of the resource.

Best Resource

The best resource for participants depended on a few different factors, the environment, if confusion was related to assessment, and who might be the most knowledgeable. At a large university, classes will sometimes be conducted solely by professors, there may be TAs that have supporting roles, or they could be the ones leading lab or discussion sections. Bojing identified this distinction, noting that for courses where TAs are "in charge," he would "typically ask TAs first." Marisol went through a similar thought process, though defining the bounds of the most effective resource to be slightly smaller. In her case, she was confused about a "house cleaning thing [...] and so I knew that [the TA] was in charge of it, and she could probably take care of it." Both of these participants outlined that the best resource, for them, may depend on who is leading the class or responsible for targeted pieces about which the individual is confused.

Similar to who is "in charge," other participants determined the best resource based on whether or not their confusion was tied to an assessment. Julián's confusion stemmed from a discrepancy between the course reading and statements made by the professor during lecture. Because he knew he would be quizzed on this content at the end of the class session, he chose to use Google to try to resolve confusion, but ultimately decided that this was not the best resource. Rather, he returned to the professor "because I felt like if she created the quiz, then she's more likely to grade us based on what she says." Julián's

determination of what was the best resource impacted his decision about who, or what, to turn to for help in addressing his confusion. Similarly, Dean felt that when confused about a paper, his professor would be the best person to ask because "she assigned it." Based on these experiences, it appeared that some students were determining the most effective source based on who would be judging their performance or who was in charge of the assessments on which unresolved confusion could have deleterious impacts.

Another characteristic participants took into account when determining the best resource for addressing their confusion was who or what could provide the most helpful information. Jada discussed deciding between searching online and asking TAs or professors, describing how she

> ...would go to, like, the professor and TA first, just because, like, they're ultimately the ones teaching the course. So they would know the best way to explain it. And, like, sometimes with the internet, like YouTube videos, it's very broad and kind of maybe not what the professor was kind of looking for. So that's why I think, like, going to the TAs and professors first is, like, a good option just because they can send you in the, like, certainly right direction.

Jada recognized her professors as being knowledgeable, and also helping to direct her efforts when confused. Rather than searching on the internet, potentially finding tangential information that would not support performance or participation in the class, she deemed going to the person teaching to be the best choice. And when distinguishing only between authority members from the class, Miles preferred to avoid TAs and ask for help from professors because "they're probably the most knowledgeable about the subject." In this way, professors may be the most efficient source for help, with participants believing there was a higher probability of resolving confusion from them rather than the TAs.

Three participants discussed how when they experienced confusion, the best resource would provide a new perspective. During class, if Dean found himself confused,

he would seek a resource other than the professor, because "maybe if someone else explained it, their method of explaining would be better. [...] Or getting that other angle on it could kind of [...] make it click, whatever it was, that wasn't clicking before." Aalim shared this perspective, being concerned that after watching pre-class videos curated by the professor and attending lectures, "if I go to office hours and she reiterates the same thing, then I'm not making any progress anywhere." Although presented in different ways, it appeared that these students shared a perspective of their professors as only capable of providing one explanation for a point of confusion. In this case, searching for other sources was the most productive way to address their confusions.

Time was a factor mentioned by eleven participants as impacting the decisions they made and resources they sought out in response to their confusions. For six participants, they considered their perceptions of whether or not the resource was efficient and could serve their time sensitive needs. With desires to want to move past their confusion as expeditiously as possible, participants like Joel and Bojing decided to reach out to their professors knowing that they'll "respond pretty quickly" (Joel), though this may be a class-specific action depending on one's professors' previous behaviors. In Meilin's case, she did not necessarily emphasize the rate of response from professors, but noted that having conversations with them was more "efficient" than going back to the textbooks and trying to search on her own for resolution. Conversely, Hakesh emphasized that asking anyone, whether a friend, a professor, or a TA would result in a delay, and it was "more immediate to find something that's, like, already posted on the internet." Alicia shared Hakesh's concerns about a delay in response, but connected it to instances where she was under pressure to resolve her confusion:

> Usually, I think part of the reason I also, like, hate asking for help is because, like, the assignments have a due date, right? But sometimes I don't always do them

> ahead of time. [...] But like if it's, like, due really soon, it's, like, kind of embarrassing to ask the professor, like, 'Hey, this assignment is due in like three hours but I'm kind of stuck on this part.' [...] And what if he doesn't respond in time?

Participants' views of "efficient," and whether they were uncomfortable with or could not afford a delay seemed to impact the source they determined as the best for aiding in confusion resolution.

Another timing circumstance was when participants felt they needed to resolve confusions immediately for personal reasons. Kassandra expressed this sentiment, being worried that if she

> ...didn't address [confusions] as they arise, [...] then I'm going to forget about why I was confused, and, you know, what it was about, [...and] the context of where I was that made me feel confused. And it's going to get buried and overlooked and then later on, I would end up just being more confused.

Therefore, she was more likely to choose resources that would be efficient in helping her address her confusion so she would not have to wait for resolution and risk future, compounded confusion.

For three participants, a lack of time was a concern when determining how to respond to confusion. Raneem reported that her confusions took a great deal of time to resolve, so she was experimenting with efficient ways to address them. Casey had a slightly different problem in that they would leave their confusions to fester until it resulted in assignments being late. At that point, they felt they could not access certain resources like their peers in the discussion board because of their tardiness. Thus, for Casey, it was not a matter of determining what resource was best, but what resources were left.

Perceptions of Resource

In deciding what resources to tap into for assistance addressing confusion, participants voiced that their perceptions of them played a role. These included concerns about their relationship with the source or what judgment may ensue from seeking help in certain ways, the relatability or comfort they felt with the source, the messages received from authority, and the accessibility of the source.

When considering seeking help from others, some participants voiced that they engaged in analysis to determine what might be the results of those interactions. Often, these concerns were projections, not necessarily rooted in tangible responses from others. However, such concerns do not delegitimize the very real impact these thoughts had on participants' behaviors.

Perceiving oneself as distinctive, different from the group in some way, could heighten concerns about judgments from others when considering seeking their help in addressing confusions. Recognizing that most of the students in the class she was taking were undergraduates, being a master's student made Mariah reticent to ask for help:

> ...it can be kind of, like, embarrassing cuz like 'Hey, I'm a master's student. I'm getting confused by very simple instruction.' [...] I'm constructing these ideologies that [my peers] probably don't have and thoughts that they don't have about me. But, like, it's just so natural at this point. That was my first thought, I was like, 'Okay, I'll just keep quiet.'

In her case, the concerns about what judgments peers might make of her if she asked for help led her not to turn to them as resources for addressing her confusion. Alicia encountered a similar situation, feeling different from others by taking a statistics class while not a math major. Interestingly, her concerns were compounded by the online environment. She reflected that learning online

> ...has been fine, but, like, you definitely don't know who's in your class. So, I'm like, well, I don't know these people and, like, maybe they're, like, really mean if I ask a really stupid question. Which I know I will ask a stupid question because I don't know what's going on, and I'm not a stats major.

Unable to develop similar relationships to those that may arise in in-person settings, being online increased concerns about perceptions from others, impacting Alicia in a way that made her reticent to ask questions about her confusion during class time.

Being perceived as burdensome or ruining a relationship was another concern impacting how participants addressed their confusions. Although Joaquin recognized his TA as being a useful resource for helping to address his confusion, he had worries about seeking help from them: "I don't want to, like, sound bothering [...] to my TA or whatever. Like, I just want to keep a cool relationship with my TA, like, I don't want to, like mess things up or something." Another participant shared similar sentiments about not wanting to overstep in a relationship with a peer. She expressed doubts, "I don't know if I'm bothering her or annoying her, [...] but I start to feel, like, really self-conscious if I'm the one always asking [for help]" (Alicia). When the relationship was not seen as equal in terms of how they were relying on one another for help, Alicia had concerns about continuing to seek help from her peer and was considering the use of alternative sources to address her confusions.

Relatability references the ways in which participants felt a connection with a certain resource. In all cases, when there was a shared identity or experience, participants felt comfortable using these sources for help addressing their confusion. Kamilah touched on two identities and discussed how these impacted her perceptions of her resources. When comparing her sense of comfort seeking help from peers in her biology versus humanities courses, she drew on her domain identity associated with being a biology major: "since I have more of a connection with the bio people [...] I feel more comfortable asking them for

help if I'm confused over anything." Kamilah again referenced her sense of similarity when describing her decisions to seek help from peers rather than her instructors:

> I think that I would just feel more comfortable going to, like, students because, you know, we all are struggling in some way, we might--they might not be struggling in this class, but somehow, they'll understand, like, 'Okay, she struggled. Let me help her out.' [...] not saying that [instructor's name] wouldn't help or anything, I just would feel more comfortable going to somebody, like a student.

In this scenario, the sense of relatability that accompanies being a student, and struggling in similar ways, was important for Kamilah in determining what resources she would use to help address her confusions. Aalim did not share this sentiment, but rather transposed it to his consideration of comfort in reaching out to the TAs. The fact that "they've gone through my situation" made Aalim feel TAs were not only a relatable resource, but also a useful one.

Although not frequently expressed among participants, one individual described their professor as "really relatable because he includes, like, tweets or stuff with his lectures" (Risa). Another participant echoed these sentiments about the same professor, describing him as having "an approachable personality that just makes it easy to talk to him about, like, you feel like, whatever" (Bojing). Both of these students found his relatability and approachability made them feel comfortable seeking help from him, and they identified using him as a source for addressing confusion.

Other participants added to the sentiments about the characteristics and actions professors took, identifying what made them comfortable in using them as resources when confused. Dean noted that he, undoubtedly, felt comfortable seeking help from his professor, describing how "she seems really open. And she also seems passionate about what she's teaching [...] and you know she, like, cares about, you know, the--what you're actually learning and what she's teaching." This care and consideration was something

Raneem felt with her professor whom she visited during office hours, emphasizing how her professor

> ...is really patient and good at explaining [confusing concepts…] She doesn't mind going slow, like really slow, she'll still treat it normally. Because, you know, there are like those teachers that are like, 'you don't get this?' She doesn't do that. Even if it's something that you should get by now, she'll still go through the process. And then when--when she's, like, teaching it and she's asking me questions to make sure I understand it, and I don't understand it, I don't necessarily feel dumb. I like that. So, I guess the shortcut answer: She's--she's a comfy person.

Previous experiences where a professor displayed their care and allowed students to feel fully vulnerable without judgment contributed to feelings of comfort continuing to seek assistance from them. The characteristics professors were perceived to have and the implicit messages surrounding help-seeking seemed to impact the ways in which students viewed them as a resource in the process of confusion resolution.

The ways a professor interacts with their class communicates important information that students take into account when determining if they feel comfortable seeking help from them to address their confusion. In Marisol's case, she described her professor as a "very warm person, a lot warmer than my other professors. So I feel, like, slightly more comfortable going to her about any questions I had about the course." Joaquin expressed the opposite sentiment when recalling a time when a professor was "mad" at many students for completing an assignment incorrectly, a result of them not watching a resource video about how to maneuver it. He described that this made him "feel, like, not as welcome to ask the teacher for help because of the way she's talking [...] she sounds super pissed off and stuff. Like, I feel if you would ask her a question, she wouldn't be, like, super helpful." Whereas Marisol felt the implicit messages she received from her professor made her feel that her professor could be a worthwhile resource for addressing confusion, the messages Joaquin experienced led to the opposite response. In his case, the lack of comfort he felt

with that professor impacted his thoughts about her as a resource, now determining that he would likely not seek support from her in responding to confusions.

The explicit messages classroom authority figures communicate to their students can impact the resources they choose to access. For a few participants, these messages came in the form of telling students what resources to use. Communicated from professors, they would typically inform learners that they should not seek help from them, at least not first. Instead, they should "go to the TAs" (Miles) or "look on Piazza to make sure [the question has] not already been answered" (Kamilah). Otherwise, as Kassandra experienced, professors may respond to questions with "'It's on the syllabus,' and, you know, 'if you read the reading, then you would understand.'" In these cases, Kassandra was unlikely to reach out to the professor for help, finding their messages encouraging her to seek support from other resources. According to these participants, professors may communicate a process, or at the very least, the resources students should consider accessing when addressing their confusion.

The accessibility of resources impacted how participants would make use of them when responding to confusion. Seeking help from professors in office hours was an action several students attempted but found to have mixed results. Aalim reported seeking help from TAs more often than professors, as their office hours were more flexible and, he believed, attracted fewer students. This turned out to be an incorrect perception, as Raneem, who was in the same class and attended both TA and professor office hours, found:

> Whenever I go to [the professor's] office hours, there aren't that many students. And so it's a one-on-one, and I can just ask what I need to and go at my pace. Whereas at the TA office hours I go to, there's always a couple of students and so I don't want to, like hinder them and their time while they're there.

This did not diminish the fact that, especially online, other participants found that "office hours are super clogged" (Casey) and because of this, "getting your question answered is, like, very minimal. [...] And normally, if I have questions, I usually ask, like, my friends or, like, I'll go to, like, [...] Piazza" (Kamilah). Unfortunately, for another participant, the professor restricted the number of students who could attend office hours, sometimes finding that when he chose to go the slots "were all reserved" (Julián) and he was unable to get his questions answered. Having access to a resource's time was integral in determining if seeking help from them was worthwhile or if they needed to turn to other sources. In addition, it seemed that students' perceptions, in addition to true experiences, could play a role in their determinations of accessibility.

Another facet related to accessibility was how easy or difficult it was to get in touch with a source. In the online space, participants' comments reflected a pattern that they were hoping to seek help from professors and found that to be difficult, especially outside of office hours. Although some of the burden may have been alleviated by being able to speak with peers during out-of-class time, this course of action was not frequently discussed by the participants. Rather, they expressed wanting to address confusions with professors, though finding that to be a burdensome task. Whereas in person, learners may be able to approach a professor at the end of class to ask a question, Bojing reflected that "it's just gotten worse when things moved online because now it's kind of hard to ask your professor to stay on the Zoom call afterwards, I think, for some larger classes." Similarly, the online space created a sense of distance that made using the professor as a resource nearly impossible for Joaquin:

> I started emailing the professor and, like, they would tell me 'No, I can't meet with you.' [...] I wanted to ask her, 'Hey, like, could we meet up because I'm not doing very well in the class,' [...] But she never, like, met up with me. I guess she's just busy.

In his case, the professor's accessibility impacted Joaquin's ability to use them as a resource, causing him to seek help with confusions from a tutor instead. Although some professors made themselves accessible to students through office hours and emails, those who were unable altered the resources students saw as worthwhile in helping them to address their confusions. Importantly, the move to remote learning may have made peers a less accessible resource than they were during in-person instruction, shifting the onus of serving as a primary resource to professors, a role in which they may not have had the capacity to serve.

Environmental Factors

Parts of their environments influenced the ways participants responded to confusion. Whereas the first two factors I discussed in this section focused on individual or source-related elements, in this category, I consider how factors like class type, where the confusion or learning takes place, and how learning remotely play a role in the decisions learners make about how to proceed when confused.

Class Type

The type of content or structure of a course had impacts on how students behaved when they were confused. For example, in a lecture-dominated class, Porter would refrain from addressing his questions immediately by asking the professor for help because he felt "like [the professor] has a lot of stuff to get through in lecture. So I don't really want to interrupt it all that much." With the structure of the class being a lecture, Porter made a decision to ignore his confusion temporarily. Part of what influenced this decision was knowing that he would have a recitation or discussion section for that class a few days later that he deemed "a class made for us to ask questions in [...] So I'll just ask anything I have."

In this case, with the distinct difference in structures of the two parts of the course, he chose to ignore confusion during lecture, but seek help by asking questions of his TAs during the recitation sections.

Another class-related factor impacting how participants chose to move through their confusion was the content it covered. When taking a class that she deemed to be very "personal," Marisol believed "it would be hard to reach out for people and resources, and I wouldn't feel necessarily too comfortable to ask someone [about confusions]." According to Marisol's experiences, she may be more open to address her confusion by seeking out help from others if the class content was disconnected from personal experiences and thoughts, but in this space, she would turn to other methods when confused. Bojing introduced another content-related distinction, whether a class was applied versus conceptual. When describing his experience of confusion in a statistics class, he outlined a step-by-step process for how he resolved confusion. However, he felt this course of action was not as appropriate in classes that are more conceptual where he found he would "need to, like, just go back and reread stuff instead of, like going through the steps." These two participants introduced the idea that class content is multidimensional in nature, and learners' judgments of that content can impact how they decide to proceed with their confusion.

An additional distinction a participant made that impacted how they coped with their confusion was if a class was in- or out-of-major. In describing his experience with confusion in a humanities course, he drew on the fact that

> ...it's not my major class. Like, I'm majoring in bio right now. So, like, these are my, my core, like, hardcore classes, like my sicence, my sciences, my biology, and my chemistry. And like my [humanities] class and my [other, non-stem] classes, [...] I just look at them as, like, my extracurriculars. (Joaquin)

In his case, Joaquin found himself more likely to be frustrated by and spurred to address his confusion in his major-related courses. This differed from his experience in his humanities class where he expressed more comfort with and frequency of ignoring confusion.

Where Confusion or Learning Occurs

Three participants identified that the space in which they were learning or where they were recognizing confusion impacted how they chose to respond to confusion. When doing homework or an assignment, for example, Hakesh found that he could work at his "own pace, and I can resolve the issue very, like, immediately, basically." However, for him and another participant, they were likely to decide to ignore confusion temporarily when it occurred during class because the professor was continuing to move on to new content. To the participants, it was important to them, at the very least temporarily, to ignore confusion so they could continue learning. This sentiment was in stark contrast to Bojing's experiences, where he felt it necessary to address confusions occurring in class immediately. For him, interrupting his learning experiences, "stopping for a little while let me understand [the confusing content] enough so that I could, like, at least sort of, like, keep up with the train of thought." In Bojing's case, getting to a point where he would still have some interim unresolved confusion, but not so much that it interfered with learning was important for him to continue understanding class content. It appears that some learners believed that ignoring confusion during in-class sessions was more productive for their overall learning, whereas others found immediately addressing their problems to be necessary.

Online

Ten participants reflected on how learning remotely and through online platforms impacted their decisions about how to respond to confusion. Their comments touched on two primary factors: feelings of disconnection and features of the platforms.

Feeling disconnected from others was a common sentiment among participants, specifically when considering differences in their response to confusion between in-person and remote settings. Almost all of their responses centered on the notion that they were unlikely to reach out to peers when addressing confusion as they were unable to create relationships with them. Some of this was due to a class being large and, for Kassandra, feeling that she was "not present with these people. And so I don't feel as connected with them." Not "knowing" peers was a common refrain, where Porter reflected this would not be as severe a problem in person where he could ask:

> 'Hey, what's your phone number? Like, I am really confused on this. Do you want to, like, meet up on campus in, like, the [student center…], you want to work on stuff together?' Now, I joined a class with people I don't know. And I don't know any of their phone numbers. And I don't see them in person. So I feel like it'd be kind of weird to, like, message them and ask for their phone number to figure out if we could work on this together.

For Porter and Kassandra, the disconnection they faced impacted how they would address their confusion, in this case, being less likely to rely on their peers as a resource when addressing their confusion. However, Casey found the disconnection to impact whether or not they addressed confusion at all. Having a friend in the class, for them, would provide accountability and a clear source for resolving confusion. Without that connection, they found themselves choosing to ignore their confusions. Based on these participants' experiences, the online setting made learners less likely to turn to their peers in the process

of addressing confusion, and in one case, led the student to ignore their confusion due to this missing resource.

Particularities of the online platforms students used impacted the ways they could or chose to go about responding to their confusion. Two participants had experiences where their classes were streamed through a one-way platform. This differed from other classes hosted on Zoom where students could interact with the professor live or through the chat, they could put their videos on, and go to breakout rooms. Rather, this course functioned as a webinar where students did not have the ability to ask questions during class time. The two participants had different responses in this scenario, with Jada resorting to addressing confusions on her own, whereas Julián decided to approach the TA outside of class time.

In contrast to the two participants who were unable to ask questions during class sessions because of platform constraints, two others had concerns about asking questions even when it was possible. Both indicated that they were worried about the nature of asking questions online and how that might lead people to judge them. Posing questions in the chat may go unaddressed due to the professor not noticing, or not finding it until the topics had moved on to new content. Other ways of asking questions of professors include using the "raise hand" button or unmuting and interjecting during the session. Although Mariah expressed that asking questions of the professor during class was a tactic she would like to use to address her confusion, she did not want to engage in these behaviors when online. She found that when students used the "raise hand" button,

> ...it's not always seen [by the professor], which means if it's not seen, then everybody else can see that you've raised your hand and that the teacher's not addressing it. But then if you don't do that, you have to interrupt. And usually when you interrupt someone, like in person, they can usually see the cues of like, 'this person is trying to get my attention and I will stop doing what I'm doing.' But in Zoom, you basically just have to unmute and be like, 'hello?' Which is, like, super awkward and I don't like doing that.

For these participants, the platform features made asking questions a potentially embarrassing or awkward experience, and they were less likely to engage in this action when taking classes online.

Although the shift to remote instruction seemed to impact negatively students' ability to address questions, there were others who found certain platform features to be productive in their process of experiencing confusion. As introduced previously, some participants mentioned that the Zoom chat was not a productive resource for resolving confusion. However, in Kamilah's class, some of her peers would use this space to note important points or content in case their peers were confused or missed explanations from the professors. Due to how the class itself used the chat function, Kamilah saw it as a productive site to turn to when she was confused. Similarly, Porter found the way the platform could be used to facilitate interactions with peers, a resource to which he had previously been reticent to use. If he experienced confusion during class and was later placed into a breakout room with a small group of peers, he would use them as a resource to address the problem because "you're, like, kind of forced to talk to other people because you're stuck in a room with, like, four people. It's kind of awkward if nobody talks." Although the online space led Porter to feel disconnected from peers and be unlikely to seek help from them outside of class, the online platform did impact how he responded to his confusion in two ways: it facilitated addressing confusion during class time when he otherwise may have ignored it, and the breakout rooms encouraged him to use his peers as a resource when he was confused, something he likely would not have done during lecture.

RESULT OF CONFUSION

After determining how to engage in confusion and moving through those processes, students will arrive at one of three results: interim unresolved confusion, terminal

unresolved confusion, or resolved confusion. In this section, I will discuss the participants' thoughts on these outcomes and their considerations of what may occur as a result.

Unresolved Confusion

For many participants, an outcome of their confusion was that they did not resolve it. This could occur as an interim response, or they could leave their confusion permanently unresolved. A student may not be able to resolve their confusion after attempting to do so, leading them to exist in the interim unresolved confusion space. For example, after Meilin asked questions of her professor as a way to address her confusion, she found the session did not lead to resolution: "I just didn't really, like, understand after she explained it. So...so really quite confused. Oh, and I really hope I can get the right answer on the next test." An impact of unresolved confusion is that it could lead students to performance concerns, especially if an impacting factor that led the learner to address confusion was their goal of performing well in the class. From being unresolved, Meilin could decide to re-address the confusion, perhaps through the use of a different source. Alternatively, she could choose to ignore the confusion, potentially deciding to let it become terminally unresolved. Both scenarios played out in Julián's experience, where after cycling through interim unresolved confusion and attempts at addressing it, he found "there's no point in picking at [the confusion] because I just don't know" how to resolve it. For certain students, choosing to move to terminal unresolved confusion seemed an adaptive behavior.

Participants did discern that if they left their confusion unresolved, they were unlikely to "learn from it" (Mariah) and found themselves "not learning as much" (Casey) in the class, overall. Leaving an initial confusion unresolved could result in a snowball effect where learners may "not be able to move to the next topic. And then it's, like, that confusion plus this confusion, plus [...] if you don't understand this topic, you won't

understand the next because somehow this topic was related to this topic" (Kamilah). Based on these experiences of confusion, deciding to let a confusion go terminally unresolved, or leaving it in a purgatory of interim unresolved confusion, could inhibit future learning, compounding issues until they become unsolvable.

Resolved Confusion

Resolved confusion occurred as a result of taking steps to address a specific confusion. This could come about from a variety of actions and behaviors, primarily by seeking support through one's own investigations or by asking others. Although resolved confusion may be an end of the confusion process, it did not necessarily indicate full grasp of the given concept or topic. Rather, as Raneem found, she would need to solidify her understanding by continuing to engage with that idea through homeworks or other applications.

Moving through the process and resolving confusion could be a beneficial experience for students. Having established successful protocols could help for the next time confusion occurred, as "you know what to do with that confusion because you're already prepared for that" (Joaquin). Resolved confusion also may help in more direct applications for classes where later content builds on earlier ideas. The area of confusion might appear on future assignments or assessments, and resolved confusion would provide students with the foundation for understanding the new information and a strong performance.

Resolved confusion also had impacts on students' course and learning experiences. Kamilah expressed that experiencing confusion typically led to frustration with the given class, but after resolving the confusion, she would find herself liking the course again. If she had moved to terminal unresolved confusion, it was possible for her interest in the

course to wane, impacting her educational experiences. From a perspective of learning, more generally, resolving confusion was something "that motivated [Casey] to learn more, and then it was also, like, extra satisfying to get past it." Considering this scenario, resolved confusion seemed to prompt feelings of self-efficacy in the course, encouraging students to continue learning and continue putting effort into their studies. Confusion could act to facilitate learning through striving for resolution, and once a student reached this stage, confusion seemed to have the ability to potentiate future learning.

Chapter 7: Discussion

Students are creative and adaptive when learning. As evidenced by the findings from these studies, learners are resilient in the face of difficulties and think critically about how to respond to confusion, taking into account a variety of factors and circumstances. Through focus groups and interviews, I worked to elucidate participants' thoughts, decisions, and experiences related to confusion in in-person and online learning environments. My research revealed that the experience of confusion is more than a rote response, but a process in which learners take their whole selves into consideration.

The current literature on confusion has investigated its mechanisms and its induction, but rarely explored elements beyond implications for learning. I aimed in my study to bolster the current conceptions of confusion, adding student voices and perspectives to the conversation. As they are stakeholders in their academic work and educational experiences, I deemed it necessary to center learners' experiences, bringing their wisdom to the forefront of this literature (Lincoln, 1995). Their rich and honest reflections corroborated some elements of the existing literature while challenging others. In the sections that follow, I expand upon select findings, how they connect to or extend the current literature, discuss implications for theory and practice, and conclude with limitations of the study and considerations for future research.

Discussion of Findings

The findings from the two studies extend the theoretical conceptions of confusion by laying the foundation for a process model grounded in students' voices and lived experiences. These findings move beyond current confusion research in which scholars have primarily investigated the cognitive mechanisms causing confusion and the subsequent results on performance tasks, serving as a proxy for learning. By integrating

methods beyond those used in experimental manipulations in the lab, I have worked to uncover students' own conceptions of and experiences with confusion, highlighting the ways learners respond to it and why they engage with their own learning as they do.

The first set of findings I reported on in Study 1 were related to participants' perceptions of confusion, that they saw it as negative, but useful for learning. This finding suggested that though students did not necessarily want to experience confusion, they noted its benefits from a learning standpoint. Their experiences and observations corroborated empirical findings that participants learn and their learning gains may be higher when they have been confused than when not (D'Mello et al., 2014; Lehman et al., 2012a). As the participants across Studies 1 and 2 emphasized, confusion facilitated learning by leading students to spend more time effortfully engaging with productive learning strategies, oftentimes desirable difficulties, and in metacognitive self-regulation (D'Mello et al., 2010; Muis et al., 2015a). Although a reassuring finding that students saw confusion as useful, I do not want to gloss over their beliefs of it being negative. The stigmas participants identified as being associated with confusion were common in their comments and in some cases impacted what learners decided to do about their confusion. Navigating these dual perceptions may be a burden for students, but one with which instructors could assist.

With participants identifying sources of confusion as related to content, activities, or assignments, evidence seemed to indicate that an emotion, like confusion, may come about due to a perceived external locus of control (Pekrun, 2006). This evaluation may be an explanation for perceived distinctiveness (when students saw themselves as "distinct" or "different" in certain environments) serving as a catalyst for confusion, where confusion manifests as a result of uncontrollable factors like a student's major or native language. One challenge to the assertion that confusion arises due to external loci is when participants expressed that feeling confused was their "fault" or that they saw it as their "responsibility."

Although external factors may play a role, as in students in Study 2 who were learning online and facing distractions from their environments that may not have been present during in-person learning, some participants did recognize their confusion even when they had an internal locus of control attribution. The perceived distinctiveness may also inform students' ease of learning judgments. Not majoring in the given course discipline or entering a classroom where one's primary language is not spoken may have provided students with preconceptions that learning would be difficult and confusion was likely to occur in a given class session.

Participants identified that they recognized confusion primarily when learning new information or when applying information. This supports previous findings of observed confusion occurring when being presented with a new problem or during problem solving (D'Mello & Graesser, 2012; D'Mello et al., 2014), furthering cementing confusion's label as an epistemic emotion (Muis et al., 2018). Although testing, questions, or other types of applications supported confusion recognition, participants did identify confusion without this type of scaffolding, during lectures or readings, for example. This experience adds to the literature, providing evidence that there is no right or one way to detect confusion. And, although a combination of subjective and objective measures may aid in students' recognition processes (e.g., Lehman et al., 2012b), it appears that learners are adept at determining they are confused in academic and learning settings. Some of the cues students relied upon, their prior knowledge of course material or feelings of (dis)engagement, may not have been relevant for a laboratory setting and as such were a newly discovered insight from my conversation with learners about their lived experiences.

When considering their response to confusion, all participants had a concept that there was often a potential for solvability (Peterson & Cohen, 2019). This came about through students expressing their intentions or actions addressing confusions; if they had

not believed their confusion could result in resolution, they would not have made attempts to find solutions to their confusion. In responding to confusion, students made use of judgments of learning (JOLs). These can indicate to students where they should proceed in the process. If they believe they have resolved the confusion and would be successful on future interactions with the content, they may terminate the process. Conversely, they may believe they do not have a strong conception of the cause of confusion and need to revisit concepts and material. Importantly, participants shared that they, themselves, were resources for addressing their confusion, often acting as the first line in their process. Contradicting the findings of Lehman et al. (2012b), some participants had success reviewing course materials or searching online for support, showing that they may not always need scaffolding in order to reach resolution.

Some of the most industrious students were those who were first-generation, the first in their family to attend college. These students expressed that their identity and prior experiences with needing to solve problems on their own (Kusserow, 2012) may make them more likely to work through confusions individually. This is not a maladaptive behavior, rather is a strength that first-generation students bring to their college classrooms (Payne et al., 2021). A similar sentiment emerged with students who had experienced or seemed to be at an acute risk of experiencing stereotype threat. In these situations, learners who are aware of negative stereotypes for a group of which they are a part (e.g., being a woman in a STEM class and knowing there is a stereotype that women do not perform well in STEM domains) may experience increased anxiety about confirming negative stereotypes, impacting subsequent performance (Steele, 1997). The most salient example from the current set of studies was related to women in STEM fields identifying that they, likely, would not ask questions during class or of their peers. Thus, seeing themselves as effective sources for resolving confusion was a coping mechanism and a protective factor.

I found students experiencing challenges in academic environments based on their histories and identities to be some of the most resilient students (Covarrubias et al., 2019), continuing to work toward resolution of confusion on their own.

Although participants often attempted to work through confusion on their own, many also saw their peers, TAs, and professors as important resources. The reasons participants offered for engaging with others were varied, some feeling alternative explanations would be productive, some facing concerns with timing, and others looking for the most knowledgeable, sometimes efficient, resource. Several participants voiced that they had a step-by-step process for seeking sources, that they would work on their own, seek help from peers, and then move on to their professors. Students took into account their sense of comfort and relational considerations when determining who to ask for help, often gravitating toward their peers. This sentiment differed in Study 2 when investigating participants in online classes. The students I spoke with in Study 2 were far less likely to indicate their peers were part of their help-seeking processes when in a fully remote setting as compared to their in-person experiences. Not being able to make personal connections or relationships with others in their classes impacted participants to the point that they would turn to professors more quickly in their processes. This may have placed a burden on professors to be a source for helping and resolving confusions, much more so than they likely experienced during in-person learning.

Although participants often discussed their experiences addressing confusion, attempting resolution, there were instances where students chose to ignore it. The decision to ignore, for some students, came about due to utility or interest. When a confusion was judged as tied to something that would not impact a grade or future outcomes (e.g., cumulative topics, success in future employment), permanently ignoring confusion could allow students to direct their attention onto what they deemed to be more necessary topics.

Many participants also expressed how having low levels of interest in a course or content could lead them to choose to ignore their confusion permanently. This lack of intrinsic motivation hindered students from taking steps toward resolution, especially when not deemed "necessary" for performance purposes. Choosing to ignore confusion permanently could be seen as productive for students motivated by performance, especially when they are able to discern accurately information that is superfluous for reaching a certain grade.

Temporarily ignoring confusion, I believe, is an adaptive mechanism as well. For some learners, engaging in this behavior during class time allowed them to continue paying attention in class, with the hope of lessening any compounding effects of confusion. Such a strategy would not work, necessarily, in a circumstance where the confusion was foundational to the lesson and built upon over the course of the class session. By ignoring confusion temporarily, learners may protect against experiencing harmful oscillations between confusion and frustration or frustration and boredom (D'Mello & Graesser, 2012), and other negative emotions (Do & Schallert, 2004). Temporarily ignoring confusion may extend beyond affective benefits, to have productive or logistical advantages. Peterson and Cohen (2019) summarized the idea that when confused, a frustrated person will not see a path toward resolution and will be unable to break down a problem into accomplishable parts. The participants in this study highlighted how a temporary respite from confusion could allow them to move out of this frustration, to reset their thinking, and attempt the issue with a fresh lens at a later point. Although ignoring confusion may not lead to learning outcomes (e.g., D'Mello et al., 2014), temporarily doing so could facilitate eventual resolution.

Frustration was a common sentiment expressed among the participants. For some, not resolving confusion over time led to frustration, supporting findings from D'Mello and Graesser (2012). Other sources of frustration participants reported were tied to a sense of

failure or helplessness, emphasized by expressions of not knowing how to resolve confusion. Although these ideas corroborated previous research, findings that frustration resulted from a perception of low control and lack of value (Muis et al., 2015b; Peterson & Cohen, 2019) were not universally supported. A few participants expressed frustration stemming from high control situations, specifically when they felt they had self-imposed their confusion by not preparing for or fully engaging with class.

Several participants experienced frustration in part because they did value the course in which they were confused so highly. As a result of their interest in the subject matter or how the course was supporting their future goals, some participants felt frustration to be a common consequence of confusion in these highly valued classes. And, although frustration could lead some participants to choose to ignore confusion, temporarily or permanently, for others, it catalyzed them to address their issue. For one participant, in particular, a lack of frustration could make it easier for them to choose to ignore the confusion, whereas they would want to seek help when experiencing the emotion. As an activating negative emotion, frustration did not appear to facilitate learning, rather, resulting in more shallow processing of information when they were not tuning out (Pekrun & Perry, 2015). However, frustration did have the activating component of encouraging some students to seek help from others or, more generally, attempt a different way of resolving confusion.

Ultimately, my studies underscore the diverse nature of students' perceptions of and experiences with confusion. Although they may follow a similar process or path, they carry unique histories and identities that will influence the way they move through confusion and what impacts confusion has on them.

IMPLICATIONS FOR THEORY

The studies presented here are some of the few that have investigated students' experiences of confusion in naturalistic settings (Lehman et al., 2008), and the only one to my knowledge that has attempted to map the whole process as opposed to particular component parts. Primarily, researchers have focused on the emotions accompanying confusion and the results, whether learning does or does not occur following a bout of confusion. I aimed with this study to add to this foundational literature, widening the lens to incorporate students' perceptions of confusion, the actions in which they may engage, the perceived outcomes, and what factors impact their decision-making processes.

The process model I have proposed outlines the ways participants expressed how they moved through confusion. Researchers examining confusion have looked primarily at affective states and conditions related to confusion, with my studies building from these to consider the tangible behaviors and the unspoken thought processes that go along with the experience. In doing so, I have provided evidence for *why* learners feel as they do, highlighting their thought processes and the various parts of themselves that they bring into their experience of confusion.

The current literature conceives of confusion as an affective and cognitive process. However, the model of confusion I derived from participants' responses contributes to an understanding that learning is often social, with students' identities, histories, and environments playing important roles in their experiences. To ground this idea, previous findings of confusion as resulting from incongruities are important; however, having additional context, for example that those whose primary language does not match the teaching language, aids in a fuller conceptualization of how confusion arises. These rich details, I believe, are imperative for advancing the theoretical understandings of confusion.

Without them, findings related to confusion will not accurately represent the complex experiences students face in their academic lives.

Another theoretical piece on which the second study, in particular, builds is related to students' experiences of confusion in online learning environments. Previous research has investigated confusion through technologically-enriched laboratory studies (e.g., D'Mello et al., 2010) and with AutoTutors or intelligent tutoring systems (e.g., Craig et al., 2004; D'Mello et al., 2011), but has not considered how learners process confusion when in an online course. Students frequently report feelings of isolation or disconnectedness from peers in fully remote learning (Olson & McCracken, 2015), and participants' responses from Study 2 supported this finding. Important implications of the findings from my studies are that being online necessarily changes when students experience confusion, their resources, behaviors, and the factors that impact their decision-making processes. Learners adapted their processes to novel environments, indicating that the process of confusion is not universal and is subject to change based on an individual's current circumstances.

It is my hope that these studies provide an impetus for continued investigations of students' experiences of confusion in diverse environments. Doing so will ensure that researchers and instructors can work toward accurate conceptualizations of confusion and support for learners as they navigate their academic paths.

I would like to end this section considering questions to which I do not have the answer. Can a person learn something complex without being confused? It may be the case that scaffolding students through simpler tasks and content could provide learners with the necessary tools to proceed through building to complex ideas (Puntambekar & Hubscher, 2005), potentially avoiding confusions. Alternatively, a period of scaffolding, where knowledge is broken down into component parts, could result in many more instances

where information conflicts with previously understood content, leading to epistemic emotions like confusion (Muis et al., 2018).

A second question I want to consider follows: is confusion necessary for complex learning or learning about complex topics? Where complex learning "requires learners to generate inferences, answer causal questions, diagnose and solve problems, make conceptual comparisons, generate coherent explanations, and demonstrate application and transfer of acquired knowledge" (D'Mello & Graesser, 2012, p. 147), it is hard to imagine confusion not arising. In fact, D'Mello and Graesser in their paper developed a hypothetical model of affect dynamics accompanying complex learning, where all roads lead through confusion. However, I believe there are more questions that arise from the original proposition. Must a learner struggle for topics or learning to be deemed complex? And deemed complex by or for whom? Is confusion a mark of complexity? If learning something is easy, is that thing complex? In this scenario, I would argue that confusion, at the very least, is beneficial for complex learning. Confusion can facilitate students recognizing that they need to halt and change their learning process, engaging in productive strategies for long-term learning, and encouraging learners to be autonomous and enact their agency in determining how to approach the process.

IMPLICATIONS FOR PRACTICE

The findings of these studies, resulting from participants' contributions, have useful implications for college-level teaching and learning practices. First, given the stigma many students reported they associated with confusion, it would seem important for instructors to devote time to giving explicit messages about confusion and confusion resolution. Because students expressed avoiding scenarios that, though potentially useful for learning, could result in feelings of shame or embarrassment, again they would benefit from explicit

messages disabusing them of these notions. Reminding students that confusion is likely to occur often, is normal, and oftentimes good for their learning may help them to expend less energy ruminating on affective concerns or weighing the risks of voicing their questions. In addition, it is apparent that instructor characteristics and messages are influential to students' confusion processes. Being conscientious about the way they respond to students' expressions of confusion, instructors may be able to facilitate a sense of comfort for learners to share their vulnerabilities.

Incorporating active means of learning into class time may help students to recognize confusion and begin to work toward resolution during class time. Using testing through formative quizzes, informal polls, or exit surveys can make confusion known. Alternatively, learners may find their confusion goes unrecognized permanently, or is later made evident through studying or completing homework on their own. Unfortunately, waiting until engaging in active strategies outside of class can cause a burden on students to find additional time to access the instructor or others from the course. Conducting low-stakes testing during class can facilitate metacognitive accuracy (Miller & Geraci, 2014) and engaging in group discussions and reflections and help students develop metacognitive awareness (Schraw, 1998). Participatory learning opportunities can help learners consciously recognize when and about what they are confused.

Another in-class consideration for instructors would be how they create or facilitate a classroom community. During in-person learning, but especially in online environments, encouraging students to get to know one another personally could help them to see peers as a resource when confused. This may help to reduce the demands of students on instructors, but more importantly, can encourage co-construction of knowledge and teaching among the learners themselves. Taking time to check-in with students and to facilitate personal relationships among all class members can change the dynamics outside

of class, too, potentially making students of color or minoritized students feel a sense of belonging and inclusion (Thompson, 2017) that can impact how they seek help for their confusions. Specifically for first-generation students, peers and other informal sources are frequent sources of help and should not be overlooked (Payne et al., in press). Providing a foundation for developing a sense of belonging and relationships among classroom peers can assist students with a broader repertoire for seeking help when confused.

More formal sites for seeking help, such as office hours, can allow students and instructors to make intentional use of time both for supporting feelings of belonging and resolving confusion. One consideration for instructors is that students may not know effective ways to make use of office hours and/or may be intimidated attending them, concerned about wasting time. Speaking with students about how office hours can be used for a variety of purposes beyond help for poor performance (e.g., asking course-related questions arising from curiosity, musing about topics building from course content, discussing personal and professional matters, providing mentorship for future pursuits, etc.) can facilitate attendance that could foster belonging and success in the course (Guerrero & Rod, 2013), specifically for low-income, first-generation, first-year students (Means & Pyne, 2017). In addition, personally inviting students, including those who may be struggling could alleviate feelings of shame associated with seeking help when confused (Guerrero & Rod, 2013). Students should prepare for office hours to ensure that they are able to move towards resolving confusion. Attending with questions in mind or a general sense of where learning has been halted can help to direct the conversation in meaningful ways. In addition, based on participant responses, it may be important to prepare for instances where instructors cannot resolve confusion. In these scenarios, students should know it is appropriate and can be beneficial to voice that their confusion is still unresolved rather than pretend they understand.

Having accessible faculty can be useful for students, providing them with an important means of support and scaffolding through confusion. However, I want to revisit some participants' perspectives that struggling on their own through confusion can be productive for their learning. As discussed throughout this section, the messages instructors provide for their students can have great impact, and it is necessary to be nuanced in shared language. For example, though encouraging students to come to office hours may reduce some of the shame and barriers of seeking help, doing so could encourage students not to spend time working through confusions on their own. In this case, they may lose the opportunity for making connections and discoveries that could foster long-term learning. However, telling students that they must work on their own before coming to office hours could communicate to students that an instructor is too busy to see students, that they do not want their time wasted by undirected or imprecise questions. As evidenced by students, when working on their own, they may become frustrated and disengage from the process. If they do not see resources beyond themselves as accessible, they may face a permanent barrier to resolving their confusion. In this way, it may be worthwhile to encourage, explicitly, students' agency in the face of confusion. Providing them with resources or a conceptual toolbox they can use on their own to work through confusions, a foundation of belonging with peers so they have classmates to approach, and recommendations for additional supports (e.g., learning centers, tutors, office hours) could give a foundation for students to enact their agency. Coupling this with rationales for these resources (e.g., working on your own and struggling through that process can lead to long-term understanding of concepts; seeking help from a friend, TA, or professor could help to frame the content in a new way that can help you move through the barrier), and incorporating student perspectives for how these various modes of help-seeking can facilitate confusion resolution can improve student outcomes and motivations (Patall & Zambrano, 2019).

Although a delicate process, being cognizant of language when discussing confusion responses and supports can still work toward supporting student-autonomy.

Although experiencing confusion is normal and should be normalized, instructors may also have the ability not to place undue burden on their students by removing barriers that could cause confusion. For example, the financial burdens associated with accessing books or the most recent version of a textbook can catalyze confusion. If students must make a decision about using an older version of the textbook due to cost, they may be more likely to experience confusion than peers who were able to afford current, though expensive, resources. Potentially not feasible in all classes, I would implore instructors to consider ways to provide open-sourced documents or cost-effective means to support learning. In doing so, those who do not have unlimited resources can continue to be active participants in class and not face additional barriers to learning.

Other practical implications of these findings may be relevant, especially, for those in science areas. Given the science domain's cumulative nature, resolving confusion is integral for students' successes. In addition, facilitating productive responses to confusion for young and adolescent students in challenging domains like science may facilitate resilience and high levels of self-efficacy. In my focus groups and interviews with students, there appeared to be a distinction between how students experienced and addressed confusion in STEM courses and those in other domains. Often, students felt high levels of frustration when experiencing confusion in STEM classes. However, this would be accompanied by a motivation to resolve the confusion, in large part because they recognized that leaving confusions to fester would result in greater difficulties understanding future content that built on earlier ideas. Supplying students with positive interpretations of and effective responses to confusion would set them up to be successful in addressing difficulties later on in their science courses. Doing so could help students to

strengthen their STEM identities and beliefs about their abilities, potentially facilitating future pursuit of the field.

A final set of questions important for practitioners to consider are related to what participants thought about confusion. Why is there a negative stigma about confusion? Why are we afraid or do not want to be confused? Why, at a societal level, is it seen as "normal" or "good" for learning to be easy? Students may be concerned that confusion is a sign they are missing an obvious piece of knowledge others have and start to experience shame after recognition. The messages more knowledgeable others imply or explicitly communicate may play a role in facilitating and perpetuating these beliefs. Being able to prepare students to accept confusion and be open about their experiences is important, but the key is to ensure they are receiving support and encouraging messages along the way.

LIMITATIONS

There are limitations to these studies that I believe are important to highlight. One limitation is related to the generalizability of the findings given the specific population from which the findings are drawn. Although the institution where these students were enrolled has a relatively diverse student population, it is not necessarily representative of nor does it encapsulate the experiences of learners at other universities. For example, the majority of students at UT Austin apply for acceptance into their major before enrolling, and thus, may have a strong identity tied to their given domain. The perceived distinctiveness and impact of taking in- versus out-of-major classes may be more salient for students in similar circumstances than for those at liberal arts colleges where learners commonly take classes across fields and may not declare a major until later in their career (e.g., at the end of their second year). In addition, the impact factors that may be important for students at community colleges likely differ from those at campuses where almost all

students live on or near campus. Learners may have different responsibilities, goals, relationships with peers and professors, that could be distinct from the experiences of the learners sampled in these two studies.

Two other limitations were specific to the second study. The first is related to the short survey window, with interviews being conducted within 48 hours of the class observation session. Although I did ask if they had experienced confusion in the past week outside of class time, this limited timing may not have allowed for capturing the full encapsulation of confusion. In the focus groups, participants did voice that they recognized confusion outside of class, and this experience may have differed in important ways from the majority of recollections on which I based the model.

The second limitation unique to Study 2 is related to the stimulated recall procedure I used. Although the process did appear to be effective in capturing students' experiences and largely valid through triangulation with the written surveys, these reflections would never be fully accurate. The self-reports I had students engage in required them to voice their memories of thoughts and affect, memories that likely are influenced by their beliefs, the situation, and self-conceptions (Do & Schallert, 2004).

In considering both of the studies, I find it important to highlight the fact that I asked students to be metacognitive about a metacognitive experience. The act of retroactively reflecting and engaging in retrospective interpretation can integrate biases into the data and limit the findings in certain ways. Inherently, engaging in this type of data collection, participants' self-constructed realities are positioned. They are subject to their own interpretations and filtering as they engage in recall about specific events, feelings, and actions. Emotional events are shown to be remembered for a longer period of time than neutral ones (Burke et al., 1992), and central details of events are more frequently recalled when discussing negative as opposed to positive events (Berntsen, 2002), where negative

emotions may focus attention and positive emotions leave space for ambient characteristics to take on importance (Talarico et al., 2009). Moreover, the recall of emotions themselves can be biased. Ottenstein and Lischetzke (2020) found positive emotions to be overestimated during recall, while negative emotions were remembered with greater precision.

Future research could work to confront these biases through triangulation as a means to reduce threats to validity that may come about through using one means of data collection (Blee & Taylor, 2002). One method of data collection could come about through gathering user data from their mobile learning (Bernacki et al., 2020). Learning what resources students access on course pages, when they do so, when they seek information or support from other resources (online or individual) could help to expand the in-the-moment conception of confusion. Another strategy that could assist with capturing naturally occurring learning and through processes is using ecological momentary assessment (Stone & Shiffman, 1994). This method can aid in capturing data at specific moments in time in natural environments and can be done repeatedly. They have been shown to be successful in capturing meaningful and accurate data of teachers' emotional states and behaviors over time (Carson et al., 2010), indicating the promise of implementing such a method to capture students' real-time experiences of and responses to confusion.

A final limitation I will discuss is tied to both Study 1 and 2. When analyzing the findings of the studies, I was the sole individual coding, without validation and checking by an outside researcher. Given that I was alone in creating initial categories and grouping the participants' quotes, the findings, inherently, are subject to my biases. I may be missing interpretations or understandings that other individuals with different perspectives, identities, expertise, and experiences could contribute. As with all research involving

autobiographical retellings and researcher interpretations of them, there is a concern about the accuracy of these transformations. As Gudmundsdottir (1996) posited, in "research reports, we further develop our re-creations of [participants'] re-creations (in words) of their reality. Subsequent readers of our reports also re-create the informants' reality based on our re-creations of their re-creations—an endless hall of faulty mirrors" (pp. 303-4). I recognize the fallibility in this process, though hope through presenting participants' voices and thoughts directly through this process has meaningfully reflected *their* experiences and realities.

FUTURE DIRECTIONS

With this study serving as an initial foray into understanding the full process of how students experience confusion, there are many lines of future research that would prove beneficial. The first would be to verify the process model with additional studies. There is important research still to be done, qualitatively, to explore diverse students' experiences (Zengilowski et al., 2021), but it would also be beneficial to have quantitative data to distinguish the importance of specific factors on certain experiences or to verify specific paths of the model. Along these same lines, conducting future studies to determine how to adjust the process model for younger students is important. The current studies incorporated the experiences of undergraduates and a few Master's students, likely differing in distinct ways from how learners in a elementary, middle, or high school might think about and navigate confusion.

Participants from these studies also made comments about how their confusions and responses differed among domains. For example, some students did not feel they experienced confusion as frequently in humanities or social science classes as they did in STEM. In addition, participants commented feeling a greater sense of urgency to resolve

confusions in STEM classes due to their cumulative nature and the concerns learners had about performance on assessments. Determining the differences students perceive and whether or not there are distinctions between the types of confusion, impact factors, and responses to confusion across varying domains would be an interesting line of research to pursue.

Building from the domain-related elements of confusion, a common notion among my participants is that if the content or course did not interest them, they were less likely to exert the effort and devote the time to resolving confusions. In this case, it may be meaningful to investigate how curiosity could be an asset when students face confusion. How is it that instructors could capitalize on students' curiosity to lead them to resolve confusions rather than ignore them?

Lastly, the research differentiating constructs of uncertainty and confusion, in addition to confusion and curiosity is limited in scope. Future qualitative investigations could build on the rich details from these two studies, providing more context about the differences students experience or how they differentiate between these ideas. Quantitative or mixed-methods studies could also prove useful to provide additional validity to distinctions learners identified between these constructs. These potential studies would help to provide needed clarity and depth to the current conceptualizations of uncertainty, confusion, and curiosity.

CONCLUSION

Confusion is both a metacognitive and emotional experience. On the one hand, at the foundation of confusion is a student's metacognition. A learner must be able to recognize when they feel confused in order to take appropriate and effective action. Learners should strive to bolster their metacognitive awareness, so they can identify times

in the learning process when they may need to engage in different actions and strategies than they had been using previously. Specifically in the case of confusion, recognizing when one is confused is the first step in being able to take appropriate action to resolve it and continue learning.

On the other hand, confusion can be conceived of as an emotion. Emotions can signal to students that something is awry, and it has the potential to motivate them to take action. From the viewpoint of educators, knowing about the emotions a student is experiencing when learning can help one to be more sympathetic and helpful. If an instructor recognizes the expression of confusion in a student, they can scaffold them in appropriate ways to achieve learning goals. In my view, one of the critical points that makes confusion a particularly interesting phenomenon is that it represents a cognition *and* an affect, leading to far reaching implications for how we examine student learning.

Confusion likely is experienced by all students at various times in the learning process. Although it is a beneficial experience when students engage in active strategies to resolve it, or if they have help from another, confusion can be detrimental for student success and for their perseverance if left unattended. By having a more thorough conception of how students experience confusion and what leads them to determine how to react to it, more meaningful interventions and tools can be used to support students when they reach these intellectual crossroads.

Appendices

Appendix A: Study 1 Semi-Structured Focus Group Questions

Confusion Baseline

- In the past, what situations or experiences have led to you being confused?
- What does confusion look like for you?
    - Does this look different depending on the context?
- How do you feel when you are confused?
- Some students have said confusion has a negative connotation. What are your reactions to this?

Responses to Confusion

- What do you do when you are confused?
- Do you run through these, or is it more of a visceral reaction?

Contextual Impacts on Confusion

- Are there certain classes where you feel confused more than in others?
    - What factors about these make you feel confused more frequently?
- How does your preparation prior to class influence your experiences of confusion?
- How does your approach to classes (what you want to get out of it) change your response to confusion?

Prior Experiences of Confusion

- In the past, have you had success or failures when you've been confused? How have these influenced what actions you decide to take in the future?
    - How have you changed your response to confusion over your undergraduate career?

Metacognitive Elements of Confusion

- In the literature that I'm reading, it says that confusion is helpful for learning. What do you think about that?
- Are there times you feel your confusion goes unrecognized?
- What is the end result of confusion like for you?

APPENDIX B: STUDY 2 SURVEY QUESTIONS

Demographic Information

Q1. What is your UT Austin year specification? *[select option]*

- Freshman
- Sophomore
- Junior
- Senior
- Other

Q2. What is your academic major? *[open response]*

Q3. What is your current UT GPA? *[open response]*

Q4. Are you the first person in your family to attend college? *[select option]*

- Yes
- No

Q5. What is your ethnicity/are your ethnicities? (check all that apply) *[select option, optional open response]*

- African-American/Black
- Asian/Asian-American
- European American/White
- Hispanic/Latin-American/Chicanx
- Middle Eastern/North African
- Native American/Indigenous person
- Not listed

Q6. What is your gender identification? (check all that apply) *[select option, optional open response]*

- Female
- Male
- Non-binary
- Prefer to self describe
- Prefer not to respond

Q7. What is your birthdate (mm/dd/yyyy)? *[open response]*

Q8. What are the digits of your EID? (e.g., xyz123 -> write "123"; will only be used to link past an future surveys). *[open response]*

Experience of Confusion

Q8. When you say "I'm confused," what does that typically mean? *[open response]*

Q9. How often are you confused in this class? *(select option)*

- Every time I am in class or interacting with the material/assignments
- Most times I am in class or interacting with the material/assignments
- Some of the times I am in class or interacting with the material/assignments
- Rarely when I am in class or interacting with the material/assignments
- Never when I am in class or interacting with the material/assignments

Q10. Was there any point during today's class when you felt confused? *[select option]*

- Yes
- No

Q11. Can you recall a time in the past week outside of this class session (e.g., when completing homework or reviewing for assignments) when you felt confused? *[only displayed if answer to Q10 was "No;" if answer to Q10 and Q11 was "No," skipped to Q19; select option]*

- Yes
- No

Q12. When were you confused? (select all that apply) *[A subset of these options were shown depending on the individual course's features; select option, optional open response]*

- The professor/TA was explaining new content
- The professor/TA was reviewing old content
- The professor/TA asked a question
- A peer asked a question
- In breakout rooms
- Completing lecture worksheets during class
- Completing activities in class
- Completing experiential exercises in class
- Answering attendance questions
- Watching lecture/module videos outside of class
- Reading/participating in the discussion board/Piazza
- Reading material outside of class
- Completing an assignment (e.g., homeworks, lab assignments, projects, papers) outside of class
- Preparing for an exam/quiz
- Taking an exam/quiz
- Attending a lab/recitation/discussion session
- Attending office hours
- Other

Q13. What were you confused about? *[open response]*

Q14. What led you to feeling confused? *[open response]*

Q15. How confused were you? *[select option]*
- Extremely confused (could not proceed or pay attention)
- Very confused
- Moderately confused (could proceed or pay attention, but learning was difficult)
- Slightly confused
- Not confused at all (could proceed or pay attention without difficulty)

Q16. What did you do when you felt confused? *[open response]*

Q17. Is there anything you are still confused about? *[select option]*
- Yes
- Maybe
- No

Q18. How confused are you now?
- Extremely confused
- Very confused
- Moderately confused
- Slightly confused
- Not confused at all

Q19. Would you be willing to participate in a 20-minute long follow-up interview through Zoom within the next 48 hours? (NOTE: Interview can only be conducted from DATE to DATE) *[If "Yes," participants scheduled an interview time and ended the survey; if "No," moved to Q20; select option]*
- Yes
- No

Perceptions of Confusion

Q20. Do you feel there are different types of confusion? *[select option]*
- Yes
- No

Q21. Describe the type(s) of confusion. *[open response]*

Q22. How do you feel when you are confused? *[open response]*

Q23. How does your experience (or lack) of confusion relate to your feelings about this course? *[open response]*

APPENDIX C: STUDY 2 SEMI-STRUCTURED INTERVIEW QUESTIONS

Specific to the Confusion Experience

- Can you recall for me the experience of confusion you wrote about in the survey?
- How extensive was your confusion?
- *[bringing in materials for stimulated recall and having them walk through the experience]*
- How did you feel when you recognized you were confused?
- What were you thinking about when you were confused?
- What was your response to that confusion?
- How confused are you now?

Online Class

- How do you typically go about resolving your confusion in this class?
- Do you use peers in your class as a resource when you are confused? Has this changed from what you would usually do because the class is online?
- How do/would you feel about asking [professor] questions when you are confused?
- How do/would you feel about asking the TA questions when you are confused?
- How would you describe your relationship with or connectedness to your peers from class? Would you use them as a resource when you are confused?
- How has your experience been with learning online?
- What are asynchronous vs synchronous classes like?
- How do you feel about this course as a whole in relation to your experience of confusion or lack thereof?

General Confusion

- Do you feel there are different types of confusion?
- Can you describe the type/types of confusion that exist?

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