Research Statement – Cristina Zepeda

Imagine a middle school student overwhelmed with trying to understand their math homework or a college student struggling to figure out how to succeed in their courses. Fundamental to the success of these students is how they regulate and adapt their learning processes especially as they use challenging strategies, experience setbacks, or otherwise struggle during learning. In my program of research, I investigate self-regulatory learning processes with a specific focus on two complementary constructs: metacognition and motivation (Zepeda & Nokes-Malach, invited resubmission). Metacognition consists of knowledge and skills that enable learners to monitor their thoughts and take action when they are not learning effectively. Motivation is also integral to the way learners think about their abilities and motives, which can impact their learning trajectories through persistence and effort or lack thereof. To pursue a comprehensive understanding of these processes and constructs across different levels of analysis (e.g., individual vs. classroom) and contexts (e.g., laboratory, classroom), I incorporate a variety of methodological approaches (e.g., experiments, observational studies, correlational repeated measure designs, and connecting study data to large educational databases). This integrative approach is exciting as it allows me to test and build upon theory while exploring the practical implications of research on metacognition and motivation for educational practice. Specifically, my program of research has three synergistic strands:

(1) Investigating how metacognition, motivation, and learning independently and jointly affect each other within a particular context (e.g., a physics course)
(2) Examining the longitudinal relationships among metacognition, motivation, and learning across contexts over longer timespans (e.g., development over school years or across exams)
(3) Characterizing teacher and student beliefs, practices, and preferences in authentic educational contexts to inform applied research

1. Causal relationships among metacognition, motivation, and learning

Metacognition and motivation have often been investigated in isolation, resulting in restricted views of how these constructs unfold and contribute to learning. In my work, I bridge these two constructs to create a comprehensive conceptualization of how and when they impact one another and learning. To do so, I test and inform theory via instructional interventions in educational settings where there are many contextual factors at play. To inform these interventions, I draw upon theories of metacognition, motivation, and self-regulated learning. For example, self-regulated learning theories suggest that improving one aspect of self-regulation (e.g., metacognition) should bolster other complementary constructs (e.g., motivation). Specifically, I investigate questions such as:

How does a metacognitive intervention that provides direct instruction and practice with metacognitive skills affect different aspects of student motivation and learning? I found several benefits of a metacognitive intervention for two middle school physics classrooms (Zepeda, Richey, Ronevich, & Nokes-Malach, 2015). Students randomly assigned to the intervention condition received self-guided materials that provided direct instruction about metacognitive skills (planning, monitoring, evaluating), worked examples for applying those skills, and opportunities for them to practice using the skills. The students in the intervention condition performed better on a conceptual knowledge test and a novel learning task than those in a control condition that received additional problem-solving practice. They also had higher endorsements of several types of motivation (growth mindset, mastery-approach goals, self-efficacy, task values). This study shows that student metacognitive knowledge and skills can play a critical role in learning and motivational outcomes. Some of my work also suggests that motivation can also be used to facilitate the use of learning strategies that create desirable difficulties (Wang, Binning, Quin, Del Torro, & Zepeda, 2021; Zepeda, Martin, & Butler, 2020), highlighting the interactive nature of motivation and metacognition.

Can instructional interventions that indirectly support students' use of metacognition benefit their subsequent motivation and learning? In a series of classroom experiments, my colleagues and I compared the effect of learning how to spell words with retrieval practice versus rewriting the words

(Jones, Wardlow, Pan, Zepeda, Heyman, Dunlosky, & Rickard, 2016). We found that second and third graders who used retrieval practice learned better, showed increased interest, and believed they could spell more effectively, demonstrating how a learning strategy that supports students in monitoring their understanding can increase student learning and motivation.

2. Longitudinal relations between metacognition, motivation, and learning

Whereas my first strand of research investigates localized effects of metacognition and motivation, my second strand examines how these constructs change and develop across time and contexts. To evaluate whether self-regulated learning theories can account for these longitudinal relations, I use various longitudinal methods (e.g., repeated measure designs, daily diaries, experience sampling). Understanding how these processes operate over time provides a rigorous test of theory while also informing the design of effective interventions that span across contexts.

How does metacognition interact with different motivational constructs? In two longitudinal studies with 2,325 and 207 adolescents, respectively, we found that metacognitive skills, interest, and self-control each uniquely and interactively predicted math engagement (Wang et al., 2021a). Specifically, metacognitive skills and interest compensated for each other, whereas metacognition and self-control sometimes compensated for each other, and other times metacognition bolstered the relation of self-control on engagement. Similarly, across three longitudinal studies, adolescents' growth mindsets only predicted math engagement when students had adequate metacognitive skills (Wang, Zepeda, Quin, Del Toro, & Binning, 2021). In contrast, metacognitive skills uniquely predicted math engagement across time and studies. These findings show how metacognitive skills have a powerful impact on learning regardless of time or context, whereas some motivational constructs are more nuanced and depend on other factors. Furthermore, these findings revealed that students in lower SES schools had lower metacognitive skills than those in the higher SES schools, highlighting inequities and structural barriers that impact student learning (Wang et al., 2021b).

Can proximal metacognitive and motivational measures account for the relation between distal measures and learning? With college students, I took a different approach in which I evaluated whether the positive relation between their initial dispositional motivation (grit) and exam performance can be explained by more proximal exam strategies (metacognition, self-explanation, analogical comparison) and motivations (self-efficacy; Zepeda & Nokes-Malach, in prep). Results showed that the proximal factors (exam strategies and self-efficacy) explained the positive relation between the distal factor (grit) and exam performance, revealing that interventions aimed at the more local (and adaptive) factors might be more effective in supporting student learning.

3. Characterizing teacher and student beliefs, practices, and preferences

Having an accurate representation of what occurs in authentic educational contexts is imperative for informing applied research and theoretical models of cognition and motivation. In my third strand of research, I examine how metacognition and motivation are captured by the beliefs, practices, and preferences of students and teachers via classroom observations and self-reports. This approach provides insight into how students and teachers engage in metacognition and motivation while pinpointing when, where, and for whom differentiated support would help.

Do teachers support metacognition and motivation in their classroom discourse, and what is the relationship between such support and learning? To test this question, I developed and applied a metacognitive support framework with two dimensions: the metacognitive dimension consisting of the type of metacognitive knowledge and skill, and the delivery dimension consisting of the manners and frames teachers used to provide support to their students. Middle school math teachers did support student metacognition in their talk, and this talk was positively related to student growth in conceptual math knowledge, particularly talk supporting personal metacognitive knowledge (Zepeda, Hlutkowsky, Partika, & Nokes-Malach, 2019). In a related study, teacher talk that was mastery-focused was also positively related to higher conceptual math learning (Boden, Zepeda, & Nokes-

Malach, 2020). These observational studies reveal the importance of classroom environments and the potential benefits of fostering metacognition and motivation at the classroom level.

What types of study strategies do students use? I have also examined the metacognitive and cognitive strategies college students reported using over time for three non-cumulative exams and their relationship to exam performance. Of the strategies students reported, monitoring and retrieval practice were the most common and the only strategies positively related to exam performance (Zepeda & Nokes-Malach, 2021). Similarly, retrieval practice and help-seeking were the most commonly reported strategies from a large, diverse dataset of high school students (N = 4,998; Butler, Alarcón, Een, Zepeda, & Schell, in prep). However, in both studies, only half of the students reported using these strategies, and students from traditionally underrepresented backgrounds were less likely to report using them. Interestingly, the reverse is true for motivational regulation strategies, which are strategies used to maintain or increase motivation (Zepeda, Giani, & Butler, under review). Students from traditionally underrepresented backgrounds used motivational regulation strategies more frequently than students from traditionally represented backgrounds. Why do we find these reverse outcomes? One explanation is the inequities students experience in their educational pursuits. Some students are reminded that they need to motivate themselves to learn, whereas other students have more supports in how to (meta)cognitively learn the material. One way to provide students with equitable opportunities is to build structural supports via comprehensive instruction in effectively regulating one's learning – a future direction I plan to pursue.

These findings also revealed that students were more likely to use cognitive learning strategies that incorporated feedback. In a recent study, I found that students generally value feedback and have positive views about the utility (useful for future, valuable), composition (helpful, not disappointed, detailed), and implementation (given opportunities and were able to address) of the feedback they receive in their college courses (Zepeda, Ortegren, & Butler, invited resubmission). Students also employed a range of motivational regulation strategies when they received frustrating feedback, with adaptive strategies that support intrinsic motivation being the most prevalent (e.g., reminding themselves that they want to master the material). These results support the idea that using intrinsic motivational strategies might be the most productive in facilitating student use of cognitive learning strategies that create desirable difficulties (e.g., retrieval practice; see Zepeda et al., 2020).

Future Directions

I have created a program of research that is grounded in an interdisciplinary approach that incorporates diverse psychological perspectives (cognitive, educational, learning sciences; e.g., Kim, Zepeda, & Butler, in prep), collaboration with teachers and discipline-based education researchers (e.g., Zepeda et al., 2015), and a large toolkit of methods and statistical approaches. Going forward, this foundation will enable me to expand and deepen my program of research by pursuing three new directions. The first new direction is to investigate how personalized interventions can be used to help students regulate their learning more efficiently and effectively, with an emphasis on creating more equitable learning experiences. As some of my work has shown, students differentially use self-regulatory strategies (Butler et al., in prep; Zepeda et al., under review), and these mechanisms interact differently depending on students' environments and experiences (e.g., their opportunities; Wang et al., 2021b). This work suggests that personalized interventions could be effective in helping students in regulating their learning. The second new direction is to evaluate the robustness of self-regulatory processes on learning across different contexts that vary along particular dimensions (e.g., knowledge: conceptual vs. procedural/factual; interactions: individual vs. classroom) to inform theory and practice. My third new direction is to leverage technology to support student metacognition, motivation, and learning. Technology can allow for more flexible interventions while also gathering more fine-grain process data. To support my program of research, I will pursue funding from federal agencies (e.g., NSF, IES) and private foundations (e.g., Spencer, WT Grant).