Teacher perceptions of student metacognition in project-based learning contexts before and after professional development

by

Robert B. McKendree

B.S., University of Florida, 2010
M.S., Kansas State University, 2015

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Curriculum and Instruction
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Abstract

This qualitative study investigated how six secondary school teachers facilitated learning and perceived metacognition in a Project-based Learning (PBL) instructional environment after participating in professional development (PD) on metacognitive strategies. Using symbolic interactionism as the philosophical overview, and following the Seidman interviewing technique, each participant was interviewed three times at different stages of the Guskey model of teacher change: before the metacognitive PD, after the metacognitive PD, and after implementing a PBL curriculum with metacognitive strategies. The participants included teachers who had previously completed trainings on the Food and Nutritional Sciences (FNS) PBL curriculum. Four questions guided this study: (a) how does knowledge of metacognitive strategies influence teacher perception of the learning process in a PBL instructional environment; (b) how do teachers facilitate student learning in a PBL instructional environment before and after metacognitive professional development; (c) what are educators' interpretations of student metacognitive regulation and knowledge during a PBL instructional environment; and (d) how do teachers view their roles in influencing student metacognition?

Findings are presented, including before participating in the metacognitive PD teacher-participants described the learning process as emphasizing the need for engagement, relevancy, and discovery. Additionally, their discussions often focused on the teacher as accountable for students' learning. When discussing PBL and the learning process, teacher-participants indicated PBL engages students, fosters accountability both though internal and external forces, promotes learning other than just rote memorization, and offers the opportunity to help struggling students.

Teacher-participant interviews after the metacognitive PD suggest teacher-participants were eager to implement new metacognitive facilitation strategies developed during the

metacognitive PD. However, several factors precluded some teacher-participants from fully implementing the PBL curriculum and metacognitive strategies, including decreasing self-efficacy toward facilitating metacognition, confounding conceptualizations of metacognition and PBL, and time constraints. A key finding from post-PD interviews is metacognition seemed to be a complex PD topic that challenged teacher-participant paradigms toward teaching and learning, suggesting further PD and reinforcement might be warranted as teachers grapple with how metacognition meshes with their previous learning paradigms. Additionally, at the conclusion of the study teacher-participants still perceived value in facilitating metacognition within their students, and a desire for further training in metacognitive facilitation.

Implications for practice are also presented, including the possible need for a more cyclical model for PD focusing on complex topics. A revised model for PD on complex topics is proposed, offering PD participants opportunities to implement new practices, and then further refine conceptualizations, before potentially adjusting their beliefs about teaching and learning. Further, implications for practice include increasing PD focused on metacognition, as well as incorporating metacognition into preservice teacher education programs. Lastly, suggestions for future research include examining the structure of metacognitive PD, exploring the most effective PD methods for metacognition, and inquiries into metacognition instruction in preservice teacher education.

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Acknowledgements

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Lastly, I am extremely grateful for my participant's willingness, openness, and honesty while conducting the interviews. They are wonderful educators who invest a lot of time and energy in their students.

Dedication

To the students and youngsters who do not experience learning success early in life. Let this be an example that you can do anything you put your mind to.

Chapter 1 - Introduction

Albert Einstein once said "Education is what remains after one has forgotten what one has learned in school" ("Albert Einstein Quotes," n.d.). What if we could increase student achievement, and retention, in school? Recent research on metacognition may provide an avenue for realizing those student gains. Metacognition was first coined as metamemory by Flavell and Wellman (1975). A simple definition for metacognition was proposed by Hughes (2017) as recognizing and regulating one's thinking. Metacognition is believed to have two main components, a knowledge component and a regulation component (Brown, Bransford, Ferrara, & Campione, 1983; Jacobs & Paris, 1987; Kluwe, 1982; Livingston, 2003; Schraw, 1998). Jacobs and Paris (1987) characterized metacognitive *knowledge* as involving declarative, procedural, and conditional knowledge (knowing *about*, knowing *how*, and knowing *when*), while Brown et al. (1983) described metacognitive *regulation* as activities such as planning, monitoring, evaluating, and revising. Looking at links between metacognition and achievement among students, Pintrich (2002) suggested as students reflect more on their thinking and act on those reflections, they tend to learn better. The author continued on to discuss metacognitive knowledge and its new position in the revised taxonomy of learning (factual, conceptual, procedural, and metacognitive).

Studies have shown metacognition to be beneficial to students during the learning process. In a meta-review of 179 books and papers, authors reported metacognition to be among the most important variables for student learning (Wang, Haertel, & Walberg, 1990). Wang et al. used a codebook of 228 items sorted into 30 scales of learning variables, further assigned to six broad learning variable categories. Of the 30 scales, the item most important to student learning outcome achievement was metacognition, followed by "effective classroom management,

quantity of instruction, positive and productive student/teacher interactions, a classroom climate conducive to learning, and a peer culture supportive of academic achievement" (p. 37). In a *Teacher's Toolkit* publication, Burton (2012) suggested metacognition can help students think scientifically by evaluating their thinking to "determine if it aligns with the rigorous requirements of science" (p. 15). In addition to metacognition's standing in the learning process, and further reinforcing its relevance and necessity in everyday life, it has been found to correlate with life satisfaction among adolescents (Cikrikci & Odaci, 2016).

Further studies exploring the value of metacognition have been done in other specific academic subjects as well, including reading comprehension. In a study focused on metacognition and reading strategies among 3rd and 5th grade students, Cross and Paris (1988) reported students in the experimental group receiving Informed Strategies for Learning (ISL) instruction made significant gains in metacognition and reading strategy use as compared to students in the control group. The authors further suggested these results support the notion of metacognition being an important component of learning. Similarly, in an article discussing reading and mathematics, Gourgey (1998) suggested instruction with explicit teaching of metacognitive skills is effective for improving reading comprehension. The author further described that math instruction emphasizing metacognitive strategies, such as the understanding of problem meaning and strategy choices, improved students' success – and their ability to transfer the newly acquired skill to similar problems.

While studies on metacognitive implementation in agricultural education contexts are sparse, both Pate and Miller (2011) and Blackburn and Robinson (2016) examined elements of metacognition. In a study investigating problem solving among 77 high school agricultural mechanics students, Blackburn and Robinson (2016) reported students who generated a correct

hypothesis were more efficient problem solvers than students who generated incorrect hypotheses "regardless of problem complexity" (p. 55). Students were randomly assigned to treatment groups and provided an engine with a written scenario describing a fault – classified as either simple (closed spark plug gap), or complex (debris in the main jet of carburetor). Students were then tasked with generating a written hypothesis regarding the fault with the engine before problem solving. Problem solving ability was defined in the study as "time to solution" (p. 51), in terms of how many minutes students took to "identify correctly the fault in" (p. 51) their respective engine. In both the 'simple' problem group and the 'complex' problem group, students who generated a correct hypothesis correctly identified the engine issue in less time (simple problem M=6.45 minutes; complex problem M=20.80 minutes) than students who did not generate a correct hypothesis (simple problem M=21.38 minutes; complex problem M=26.22 minutes). As a conclusion, authors suggested problem solving performance was attributable to information students "acquired and hypotheses they generated…support[ing] the importance of students employing metacognitive processes during" (p. 55) problem solving. Relatedly, Pate and Miller (2011) studied a component of metacognition by examining students' scores on an electrical circuit test using a self-questioning protocol (metacognitive strategy) as a treatment. They found students who used the self-questioning protocol scored 10% higher than students who did not utilize the protocol.

In addition to a research base suggesting metacognition is important to students' success in learning, metacognition is a skill that can be further developed by practice and explicit instruction. Recently, researchers investigated the learning environment of a chemistry classroom and its relationship with metacognition by qualitatively and quantitatively assessing the class' learning environment and students' metacognitive thinking with the MOLES-S (Metacognitive

Orientation Learning Environment Scale-Science) and SEMLI-S (Self-Efficacy, Metacognition Learning Inventory-Science) (Thomas & Anderson, 2014). Specifically, Thomas and Anderson employed an intervention that included the classroom teacher shifting the focus of learning chemistry towards using a three-level framework (macroscopic, microscopic, and symbolic). Through analysis of field notes and video and audio records authors asserted the learning environment became more metacognitively oriented and resulted "in metacognitive change in some students" (p. 153). Further, it was reported pre- and post- intervention interviews with students showed students could articulate the changes in the environment regarding metacognition, with one student offering before the intervention "I don't think he [teacher-participant] talks about how we learn a lot…seldom or almost never. We just talk about concepts; we don't talk about how we learn them."

Similarly, in another study with 119 8th grade students, authors examined explicit instruction of metacognitive knowledge in the context of control variables during 12 science lessons on reproduction (Zohar & David, 2008). Explicit instruction of metacognitive knowledge included some of the following elements:

- Knowing the name of the strategy (i.e., control of variables).
- Recognizing the necessity to control variables if the resulting inferences are to be valid and recognizing *why* inferences that are made without controlling variables are invalid…
- Knowing *how* to use the rule, i.e., compare between at least two cases in which all variables remain constant except the target variable…

- Being able to identify when to use the control of variables strategy. i.e., knowing that variables need to be controlled whenever we need to establish the existence of causal relationships… (Zohar & David, 2008, p. 64)

To assess metacognitive knowledge, researchers used a written pre- and post-test that asked students to evaluate a fictitious story about a scientific experiment. Students were then tasked with planning an alternative experiment, and were asked to: "explain why they planned their experiment the way they did" (p. 71), explain the differences between the two experiments, and to explain if valid inferences can be drawn, and why. Researchers reported significant differences for control and experimental groups in metacognitive knowledge, with the experimental group receiving direct instruction on metacognitive knowledge outperforming the control. They also found explicit instruction was beneficial for both high achieving and low achieving students, but was more beneficial for lower achieving students.

Still in the realm of explicit instruction, An and Cao (2014) embedded metacognitive soft (planning sheets) and hard scaffolding (self-questions) into a treatment group's instruction for two assignments during a graduate course. Qualitative data analysis suggested the metacognitive scaffolding enhanced students' problem solving processes (i.e. set goals, organize ideas, revise, among others), although there was no statistically significant difference on problem solving outcomes (treatment group did score higher). These studies – metacognitive learning environment, control variable metacognitive knowledge, and metacognitive scaffolding – would seem to support Lovett's (2013) postulation that metacognitive skills are best developed through practice with feedback from the teacher, within the context of the learning, and not in an abstract way.

Creating a difficulty for teaching metacognitive skills is the understanding that metacognitive skills are often internal, and not readily available for others to perceive (National Research Council, 2000). This understanding reinforces the need for educators to make their thinking visible, and ask their students to verbalize thinking as well. I postulate the employment of multiple learning modalities – such as kinesthetic, auditory, and visual – presents an opportunity to make otherwise unseen metacognitive skills used by teachers more apparent to students, an important step of utilizing explicit instruction in metacognition (Thomas & Anderson, 2014; White, Frederiksen, & Collins, 2009). Explicit instruction is important, as research has shown that "teaching, prompting, and facilitating learners' use of metacognitive skills results in improved learning performance" (Schwartz, Scott, & Holzberger, 2013, p. 91)

While metacognition has been shown to be beneficial to students, research examining teachers' understanding of metacognition in an agricultural education context is limited. In a 2017 study, McKendree and Washburn examined agriculture teacher understanding and facilitation of self-regulated learning (SRL), which is a component of metacognition according to Zimmerman (2002). Qualitative data analysis led researchers to suggest agriculture teachers had an incomplete understanding of the cognitions involved with SRL; instead, focusing their understandings of SRL on student motivation and outward behavior. Studies in other areas have yielded similar findings. Despite Wilson and Bai (2010) reporting teachers as having a rich understanding of metacognition, authors suggested within those rich understandings were contradictions. For example, contradictions such as describing the need to teach metacognition explicitly (active process with guidance) on one hand, and then implicitly on the other (assigning tasks that require metacognitive thinking, but not providing the guidance). These contradictory

findings would seem to support an incomplete understanding of metacognition by teacher-participants.

In a recent study describing metacognitive awareness as recognizing and regulating one's thinking, researchers reported similar findings: among 18 Career and Technical Educators (CTE), authors reported low to moderate levels of metacognitive awareness (Hughes, 2017). These studies' (Hughes, 2017; McKendree & Washburn, 2017; Wilson & Bai, 2010) findings were consistent with Seraphin, Philippoff, Kaupp, and Vallin (2012), who reported a group of 28 novice and experienced teachers were unfamiliar with metacognitive strategies. In their findings, teachers who underwent a year-long professional development series on Teaching Science as Inquiry (TSI) showed more awareness of their knowledge acquisition process. Further supporting metacognition as a teachable skill, authors purported "teachers and students can improve their ability to evaluate their cognitive strengths and weaknesses and learn to use that knowledge strategically" (Seraphin et al., 2012, p. 378).

As previous research suggests, teachers are often unfamiliar with metacognitive terminology and processes. Exploring how metacognitively aware teachers attempt to facilitate instruction and perceive the learning process of students, could help address gaps in the literature base. In a broad review of research on metacognition in science education, one of the four gaps in research was teachers' knowledge of, and professional development in, metacognition (Zohar & Barzilai, 2013). Knowing metacognition is valuable for students, the next step is to analyze how teachers further perceive metacognitive thinking during effective instructional strategies.

Coinciding with the need for research in teacher understanding of metacognition is a need to explore relationships between metacognition and instructional strategies. Delving further into teacher perceptions of student metacognition while using an instructional strategy that is

suggested to provide metacognitive benefits to students may provide valuable information for both practitioners and teacher-educators. This could potentially connect dots between the known value of metacognition, teacher knowledge and perceptions of it, and students' reported use of it.

An instructional strategy that has been suggested to further encourage metacognitive growth is inquiry-based teaching and learning (Blumberg, 2000; Hmelo & Lin, 2000; Loyens, Magda, & Rikers, 2008). Project-Based Learning (PBL) is a form of inquiry that has students complete a collaborative project centered on a structured, authentic problem (Thomas, 2000). In general, PBL and other forms of inquiry-based approaches are deemed beneficial in motivating and increasing the thoughtfulness of students (Barron et al., 1998; Blumenfeld et al., 1991; Krajcik et al., 1998). Further supporting the overall benefit of PBL, Anderson (2002) stated "a pattern of general, but not unequivocal, support for inquiry teaching continues to come from the research" (p. 6). Finally, while focused on content knowledge achievement, inquiry has been examined in an agricultural education setting. Thoron and Myers (2011) – in a quasi-experimental design – reported students taught with an inquiry-based approach had higher content knowledge achievement than students taught with a more traditional method.

Regarding metacognition, PBL has also been shown to be impactful by increasing students' motivation to learn and interest in the subject matter (Downing, Kwong, Chan, Lam, & Downing, 2009; Gordon, Rogers, Comfort, Gavula, & McGee, 2001; Sungur & Tekkaya, 2006), promoting elaboration strategies and self-reflection (Davis, 2003; Schraw, Crippen, & Hartley, 2006), and fostering self-directed learning (SDL) (Blumberg, 2000; Hmelo & Lin, 2000; Hmelo-Silver, 2004). Blumenfeld et al. (1991) argued PBL encourages metacognition in two ways, tactical (moment-to-moment regulation of cognition) and strategic (control over larger areas of thinking). Focusing on metacognition while using a PBL framework in CTE may also address a

dilemma proposed by Spindler (2010). Spindler reported CTE programs under study mostly incorporated lower levels of the cognitive and knowledge dimensions in Bloom's revised taxonomy when trying to incorporate scientific concepts – with the cognitive dimension containing remember, understand, apply, analyze, evaluate, and create; and the knowledge dimension containing factual, conceptual, procedural, and metacognitive knowledge. Meaning, potential opportunities to incorporate other knowledge elements (i.e., metacognition), are being missed. Examining an inquiry-based approach in CTE offers the possibility of incorporating deeper levels of thought, shifting focus away from prescribed outcomes.

However, despite the proposed benefits of PBL, research has shown hurdles exist for teacher implementation. Among the hurdles is a substantial change required in teachers' "thinking about and dispositions toward classroom structures, activities, and tasks" (Blumenfeld et al., 1991, p. 373). In a study examining one teacher's application of PBL, Ladewski, Krajcik, and Harvey (1994) found the teacher's prior beliefs challenged her implementation. The authors reported she struggled with encouraging investigation of the problem versus covering the curriculum to satisfy standardized testing demands. She also struggled with student responsibility for learning versus teacher direction of learning. Similarly, in an article reviewing the known elements of PBL, it was proposed PBL implementation has challenges with both teachers and students, as students may prefer a traditional instructional method that features more memorization (Marx, Blumenfeld, Krajcik, & Soloway, 1997). Continuing the focus on students, in a study examining eight students' initial attempt at inquiry, it was reported the students were thoughtful in planning their investigations, but struggled with drawing accurate conclusions from their project research, although the authors suggested this could be improved with teacher support (Krajcik et al., 1998).

Blumenfeld et al. (1991) postulated that in order to foster motivation and engagement in a PBL environment, teachers need to provide students access to information, scaffold instruction/guidance, encourage the use of metacognitive processes, and provide feedback. Given the benefits and challenges presented regarding metacognition and teacher implementation of PBL, and Blumenfeld et al.'s (1991) suggestion to encourage metacognitive processes, at least two gaps exist in the literature. The first is how teachers' conceptualization of the role metacognition plays in the learning process evolves through Professional Development (PD) on metacognition. The second is the role of PBL in enhancing metacognitive learning principles.

Statement of the Problem

Metacognition has been found to be an important component of academic performance, while project-based learning (PBL) has also been shown to be beneficial for students in the areas of motivation, learner interest, and helping students become self-directed learners (SDL) (Blumberg, 2000; Downing et al., 2009; Gordon et al., 2001; Hmelo & Lin, 2000; Hmelo-Silver, 2004; Sungur & Tekkaya, 2006). However, metacognition is often an unseen ability (i.e., not readily noticed by observers) (National Research Council, 2000), and it is common for teachers to be unfamiliar with metacognitive processes (Hughes, 2017; McKendree & Washburn, 2017; Seraphin et al., 2012). With little formal training in and low awareness of metacognition among teachers, more research is needed to further examine how educators perceive metacognition in themselves and their students. This study sought to explore how educators facilitate learning and perceive metacognition in a PBL instructional environment after participating in professional development on metacognitive strategies, and includes the following questions:

1. How does knowledge of metacognitive strategies influence teacher perception of the learning process in a PBL instructional environment?

2. How do teachers facilitate student learning in a PBL instructional environment before and after metacognitive professional development?
3. What are educators' interpretations of student metacognitive regulation and knowledge during a PBL instructional environment?
4. How do teachers view their roles in influencing student metacognition?

Add your content here.

Research Design of Study

For this study, the researcher utilized a series of three semi-structured interviews placed before and between a professional development (PD) experience and a curriculum implementation (see Figure 1.1 below). Interviews were conducted with teacher-participants before the PD experience, after the PD experience but before teacher-participants implemented two units of PBL instruction, and after teacher-participants implemented two units of PBL instruction. Additional details are presented in Chapter 3.

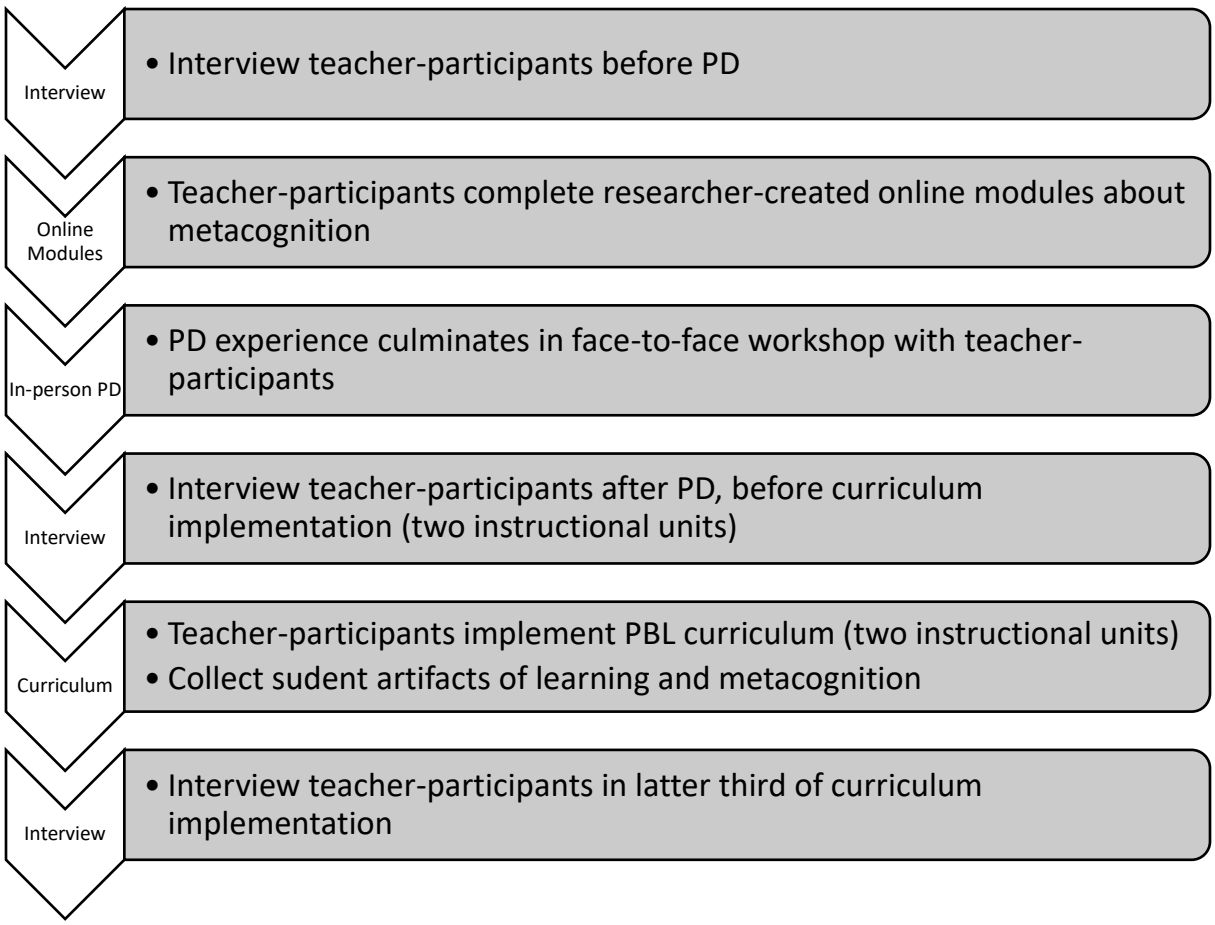

Figure 1.1 Research Design

Assumptions

For the purpose of this study it was assumed that:

1. Answers provided by participating teachers are accurate to the best of their understanding of the questions asked.
2. Participating teachers are invested in their students' growth and strive to select the best instructional strategies available to them.
3. Teachers are invested in their own professional growth and strive to utilize strategies that will allow them to grow the most professionally.
4. The researcher-created professional development experiences yielded teacher knowledge of metacognition.

Definition of Terms

1. Career and Technical Education (CTE) Educators – Academic and technical skills-oriented courses offered as part of a comprehensive high school program. May include courses such as school-based agricultural education (SBAE), Family and Consumer Science (FACS), and building trades, among others.
2. Inquiry-Based Learning (IBL) – An active learning environment where teachers utilize student experiences to generate authentic questions to inquire into.
3. Metacognition – Commonly referred to as "thinking about thinking," it is the ability of a person to "understand and manipulate their own cognitive processes (Reeve & Brown, 1985, p. 343). It involves two main elements, metacognitive knowledge and metacognitive regulation.
4. Metacognitive Knowledge – The first element of metacognition, it includes three sub-parts (Jacobs and Paris, 1987): 1) declarative knowledge a person has related to themselves as learners or about a topic under investigation, 2) procedural knowledge about how to do things, like employing a comprehension strategy, and 3) conditional knowledge of knowing why and when, such as why a comprehension strategy works or when one should use it.
5. Metacognitive Regulation – The second element of metacognition, focused on regulating and overseeing learning (Brown et al., 1983). It includes planning, monitoring, checking/evaluating, and revising activities done before, during, or after a learning opportunity.
6. Metacognitive Strategies – Explicit strategies that can be utilized during instruction to enhance students use/ability as it relates to Metacognitive Knowledge and/or Regulation.

7. Metacognitvely Aware – A person with explicit knowledge of Metacognitive Knowledge and Regulation, having the ability to apply these processes within their own thinking.
8. Metacognitively Aware Teacher – A teacher who – borrowing elements of Reeve and Brown's (1985) definition – understands not only how to monitor and manipulate their own cognitive processes, but also understands how such monitoring and manipulation can be applied to students' cognitive processes. A metacognitively aware teacher knows the terms and strategies related to metacognition, and uses them during instruction with students to help increase student awareness of metacognitive processes.
9. Problem-based Learning – Like Project-based Learning, it is a form of inquiry-based instruction that has students solving an authentic problem; however, the problem is less structured than is often the case with Project-Based learning.
10. Project-based Learning (PBL) – A form of Inquiry that has students complete a collaborative project centered around a structured, authentic problem.

Chapter 2 - Literature Review

Introduction

I discussed in chapter one how studies have shown metacognition to be beneficial to students in the learning process (Cross & Paris, 1988; Gourgey, 1998; Pate & Miller, 2011; Pintrich, 2002; Wang et al., 1990), and also found to correlate with life satisfaction (Cikrikci & Odaci, 2016). While we know metacognition is beneficial, we also know teachers may not be familiar with it (Hughes, 2017; McKendree & Washburn, 2017; Seraphin et al., 2012; Wilson & Bai, 2010). The lack of familiarity by teachers supports the need for studying metacognition situated within a learning strategy that is deemed beneficial to students, such as Project-based Learning.

While there are proposed benefits of metacognition, there has been some discrepancy about when and how people develop metacognitive abilities. Veenman, Wilhelm, and Beishuizen (2004) examined fourth-graders, sixth-graders, eighth-graders, and university students for their metacognitive skillfulness. Participants were given four digital-based tasks to complete, such as adjusting variables to grow plants (e.g., placing the plant in the house versus in a greenhouse). Researchers collected logfile data on two elements of metacognitive mindfulness: 1) the number of variables participants adjusted related to the given task, (deemed a negative indicator of metacognitive skillfulness); 2) frequency in which participants scrolled back to previous experiments (deemed a positive indicator of metacognitive skillfulness). Based on an increase of metacognitive skillfulness between the respective age groups, researchers postulated metacognition increases with age. Further, Veenman, Van Hout-Wolters, and Afflerbach (2006) purported metacognitive skills contribute "to learning performance on top of intellectual ability" (p. 6), as opposed to metacognition and intellectual ability being in sequence. Further supporting

the idea metacognition can be increased independent of intelligence, Thomas and Anderson's (2014) study on chemistry learning environments showed that metacognition can be explicitly taught. Researchers reported through pre- and post- intervention interviews with students that participants could articulate the changes in the environment regarding metacognition. Additionally, research on instruction of explicit knowledge in the context of control variables (Zohar & David, 2008) and research examining soft and hard scaffolding effects on problem solving (An & Cao, 2014) both lend support to the idea metacognition can be improved with explicit instruction.

These studies situate metacognition as an important component of learning and academic achievement and a component of learning on which educators should be focused. Given these arguments, instructional strategies that enhance metacognitive skills are significant, as National Research Council (2000) suggested, "because metacognition often takes the form of an internal dialogue, many students may be unaware of its importance unless the processes are explicitly emphasized by teachers" (p. 21).

Metacognition

Metacognition originated with Flavell and Wellman (1975) when they originally coined the phrase metamemory. Metacognition involves cognitions about cognitions (Flavell, 1979); or in simpler terms, thinking about one's thinking. Reeve and Brown (1985) defined it as "individuals' ability to understand and manipulate their own cognitive processes" (p. 343). Despite disparate conceptualizations of metacognition in educational psychology research over the past forty years (Young, 2010), researchers generally view metacognition as having two main components: a knowledge component and a regulation component (Brown et al., 1983; Kluwe, 1982; Jacobs & Paris, 1987; Livingston, 2003; Schraw, 1998). Metacognitive knowledge was

characterized by Flavell (1979) as knowledge of variables that affect the learning process, such as person, task, and strategy. Jacobs and Paris (1987) later contrasted Flavell's metacognitive knowledge elements and suggested instead that metacognitive knowledge consisted of three types of knowledge: declarative, procedural, and conditional. Metacognitive regulation was defined by Brown et al. (1983) as being regulatory activities such as planning, monitoring, evaluating, and revising. In a 2014 study of online learning environments, An and Cao postulated a model of metacognition that encapsulated both frameworks developed by Flavell and Brown et al. An adaptation of that model revised to fit the framework of Jacobs and Paris (1987), is shown in Figure 2.1:

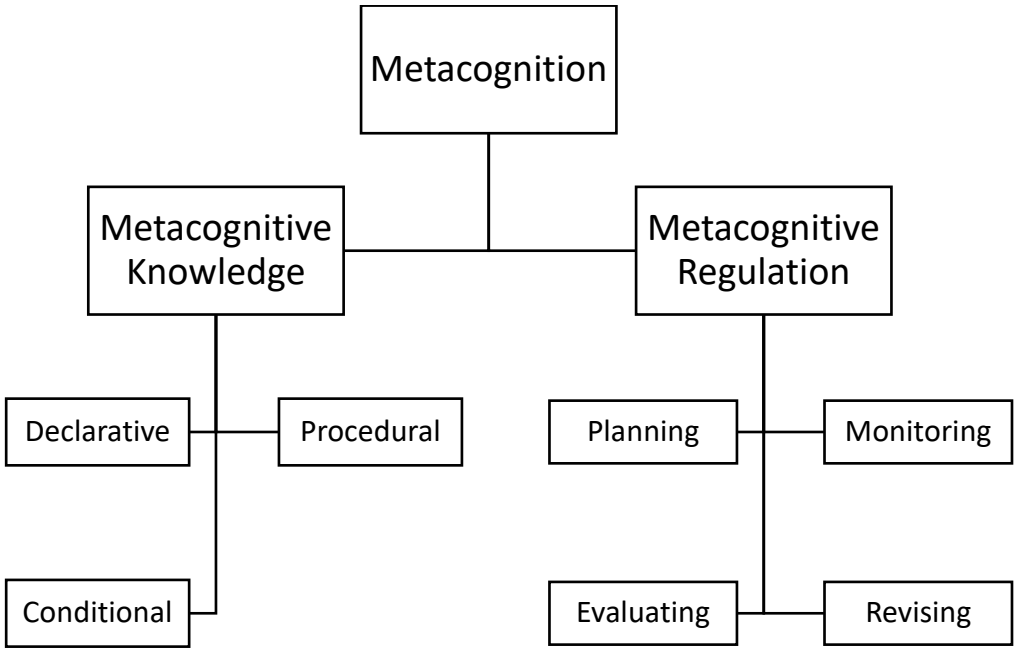

Figure 2.1 Model of Metacognition (An & Cao, 2014) adapted with Jacobs and Paris' (1987) Metacognitive Knowledge elements

Metacognitive Knowledge

A series of research studies on reading comprehension led to Jacobs and Paris' (1987) reframed conceptualization of the Flavell Metacognitive Knowledge. Jacobs and Paris cited Myers and Paris (1978) as the first study on metacognition and older readers, which used

scripted interviews and free response to examine knowledge reported about reading. Paris and Jacobs (1984) later examined the effectiveness of a metacognitive intervention designed to increase understanding and use of comprehension strategies, finding statistically significant correlations between metacognition and measures of comprehension (as cited in Jacobs & Paris, 1987).

Past findings led Jacobs and Paris (1987) to describe metacognitive knowledge as including declarative, procedural, and conditional knowledge. Firstly, declarative knowledge is familiarity with a topic – Schraw (1998) characterized it as knowing about oneself as a learner and summarized it as knowing "about" things. Jacobs and Paris (1987) highlighted metacognitive declarative knowledge in a reading context and suggested that topic familiarity plus prior knowledge when reading will influence reading speed.

Secondly, procedural knowledge, or knowing "how" to do things (Schraw, 1998), was characterized by Jacobs and Paris (1987) as an awareness of process thinking. The authors postulated that in a reading setting, this would be knowledge of strategy processes such as how to skim passages or how to underline important points. Schraw (1998) provided the examples of chunking or categorizing information.

Thirdly, conditional knowledge, or the "why" and "when" of cognition (Schraw, 1998), was proposed by Jacobs and Paris (1987) as being an awareness of conditions that influence learning. They suggested examples including knowing why strategies work or when to use a particular strategy. Schraw (1998) put forward the importance of conditional knowledge, stating it helps learners adjust to the demands of different learning situations/tasks.

Metacognitive Regulation

The second element of metacognition is metacognitive regulation. Brown et al., (1983) described metacognitive regulation as used to "regulate and oversee learning" (p. 107), including planning, monitoring and checking activities. The authors also postulated that, unlike metacognitive knowledge, metacognitive regulation is not statable (Brown, 1987; Brown, et al., 1983) – Not statable being defined as difficult to reflect on these processes and discuss with others, which is consistent with National Research Council's (2000) suggestion that metacognition is often not visible. Schraw (1998) described metacognitive regulation as a set of activities that "help students control their learning" (p. 114), and – citing Jacobs and Paris's 1987 study – proposed three skills in particular are essential: planning, monitoring, and evaluation.

Schraw (1998) described planning as selecting strategies and allocating resources that affect performance in a learning situation. Focusing on reading, he offered making predictions, allocating time, and strategy sequencing as examples of planning activities. Part of planning, and strategy sequencing, might be determining a specific set of strategies to use at different times during a learning process. Brown et al. (1983) added trial and error as an example of planning activities.

Monitoring was described by Schraw as comprehension of task performance and may include one's ability to self-test. Brown et al. (1983) characterized monitoring as occurring during learning, and suggested self-testing, revising, and rescheduling strategies for learning as examples. This could also include monitoring progress, such as a student keeping track of the time remaining in a class period while working independently.

The final aspect Schraw (1998) discussed was evaluation, characterized as "appraising the products and efficiency of one's learning" (p. 115). Likewise, Jacob and Paris (1987)

described evaluation as evaluating one's own understanding. Relatedly, Brown et al. (1983) designated this aspect "checking" (p. 107), citing it is "evaluating the outcome of any strategic actions against the criteria of efficiency and effectiveness" (p. 107). A student utilizing this form of metacognitive regulation during a project-based instructional unit may evaluate his/her efficiency in finding credible sources while researching a topic; and, if needed, seek assistance.

De Backer, Van Keer, Moerkerke, and Valcke (2016) also discussed metacognitive regulation and further delineated high-level versus low-level metacognitive thinking. The authors provided the selection of only one problem-solving method as an example of low-level, as opposed to selecting a plan after considering other problem-solving alternatives as an example of high-level metacognitive thinking.

Finally, gender presents as a variable of interest in relation to metacognition as Bidjerano (2005) and Zimmerman and Martinez-Pons (1990) both found differences in self-regulating behaviors between genders; with self-regulation being a component of metacognition and containing 15 sub-processes such as self-reflection and self-monitoring (Zimmerman, 2002). In the 1990 study by Zimmerman and Martinez-Pons, females reported using record keeping and monitoring, environmental structuring, goal-setting, and planning at a significantly higher rate than males. Likewise, Bidjerano (2005) purported that females surpassed males in their ability to use six metacognitive strategies the researcher associated with self-regulation: rehearsal, organization, metacognition, time management skills, elaboration, and effort. Several hypotheses for these differences were offered, including females having a higher proclivity of utilizing self-regulated strategies in their learning, females might have been more reflective about their learning, or females might have a higher willingness to report their use of the strategies.

Project-Based Learning

Inquiry-based approaches can be described as any activity where students answer research questions through data analysis (Bell, Smetana, & Binns, 2005). Inquiry-based learning approaches to instruction, such as project-based learning (PBL) and problem-based learning, have been suggested to enhance student self-directed learning (SDL) skills (Blumberg, 2000; Hmelo & Lin, 2000; Loyens et al., 2008) that include metacognition, such as seeking resources and employing study strategies for deeper understanding.

Project-based learning is a form of inquiry-based learning that focuses on students completing a collaborative project centered around a structured, authentic problem (Thomas, 2000). Project-based learning is related to another form on inquiry-based instruction, the similarly titled problem-based learning. Hmelo-Silver (2004) distinguished project- from problem-based learning by highlighting the differences in the problem statements that drive instruction and inquiry. Project-based approaches rely on a more structured problem that helps guide students on a path of inquiry, and is thus more teacher-driven. A problem-based approach relies on an ill-structured problem that allows for a freer inquiry approach to teaching. See Table 2.1 for a juxtaposition of project- and problem-based learning side by side, adapted from Hmelo-Silver (2004).

Table 2.1 *Project- and Problem-based Learning (Hmelo-Silver, 2004)*

	Problem-based Learning	Project-based Learning (PBL)
Problem	Realistic ill-structured problem	Driving question
Role of Problem	Focus for learning information and reasoning strategies	Focus for scientific inquiry process leading to artifact production
Process	Identify facts, generate ideas and learning issues, SDL, revisit, and reflect	Prediction, observation, explanation cycles
Role of Teacher	Facilitate	Introduce relevant content before and during inquiry Guide Inquiry process
Collaboration	Negotiation of ideas	Negotiation of ideas with peers and community members

Bell et al. (2005) further differentiated levels of inquiry, including confirmation, structured inquiry, guided inquiry, and open inquiry. Project-based approaches would align more with guided inquiry where students investigate a teacher-presented problem with student-selected procedures. Problem-based approaches would align more with open inquiry where students are investigating self-selected questions.

Conceptualizing Project-Based Learning

While referring to PBL as Project-based Science, Krajcik, Blumenfeld, Marx, and Soloway (1994) characterized PBL as an attempt to build connections between scientific principles and real-life contexts. Postulating alignment with constructivist learning theory, the authors distinguished five elements necessary for PBL: (a) engage students in solving an authentic problem, with the problem helping to structure the learning that will take place; (b) problems result in the creation of artifacts or products; (c) allows for investigation; (d) develops a community of inquiry (students, teachers, and community members); (e) promotes cognitive tool use by students.

Similar to Krajcik et al.'s (1994) five elements, in a review of literature Thomas (2000) identified five criteria for PBL: (a) centrality; (b) driving question; (c) constructive

investigations; (d) autonomy; (e) realism. While consistent with Krajcik et al. (1994) descriptions of PBL, Thomas noted explicitly the need for PBL to be central to the curriculum – meaning, the project is the curriculum and the main teaching strategy, and students learn "central concepts of the discipline via the project" (p. 3). Thomas (2000) differentiated between projects that are in addition to regular methods of teaching and projects that are the central focus of the curriculum, suggesting the former is not an iteration of PBL. Thomas suggested that a teacher teaching a subject initially with a different instructional strategy, and then having students complete a project to reinforce what was learned, would not represent true PBL.

However, the intended implementation of PBL can be impacted by teachers and students. As I discussed in chapter one, implementing PBL does include some possible hurdles for teachers and students. Schraw et al. (2006) cited adequate teacher training to use inquiry and inadequate coverage of material as possible barriers. Marx et al. (1997) suggested student beliefs and practices of learning may inhibit PBL, as students may prefer memorization. Likewise, in a study analyzing how one teacher implemented PBL, Ladewski et al. (1994) reported conflicts between premises of PBL and the teacher's prior beliefs about teaching and learning science, two of which being the need to include facts and reach desired conclusions. One could argue the findings in Ladewski et al. (1994) would be consistent with the Chinn and Malhotra (2002) discussion of authentic science versus simple inquiry: a teacher's instinct may be to rein students in and steer them towards finding expected outcomes and arriving at pre-determined conclusions, a setting that ultimately resembles simple, or guided, inquiry instead of authentic scientific inquiry.

One could argue the ultimate realization of PBL depends upon the teachers and students practicing the learning strategy. Chinn and Malhotra (2002) examined how inquiry-based

approaches (such as PBL) in schools capture the features of authentic science, and considered how resources might be a barrier to true scientific inquiry. The authors postulated that authentic scientific inquiry is complex and requires expensive equipment and resources. As a result, schools develop simple inquiry tasks with hopes of students learning some of the scientific core principles by completing these tasks. This lack of resources could result in another hurdle to PBL implementation.

Project-based Learning and Learning Gains

A form of inquiry-based instruction, PBL has been shown to be beneficial in motivating and increasing the thoughtfulness of students (Barron et al., 1998; Blumenfeld et al., 1991; Krajcik et al., 1998). Research has been conducted examining components of metacognition and differing forms of inquiry-based instruction. Results of these studies have varied, but PBL has been shown to be impactful by (a) increasing both students' motivation to learn and their interest in the subject matter (Gordon et al., 2001; Downing et al., 2009; Sungur & Tekkaya, 2006); (b) promoting elaboration strategies and self-reflection (Davis, 2003; Schraw et al. 2006); and (c) promoting self-directed learning (SDL) (Blumberg, 2000; Hmelo-Silver, 2004; Hmelo & Lin, 2000). How PBL impacts motivation, self-reflection, and self-directed learning is further explored in the following sections.

Motivation. One of the biggest impacts inquiry-based approaches can have on students is in their motivation and interest to learn. Gordon et al. (2001) examined the effects of problem-based learning in a North Philadelphia middle school with a 100 percent minority (underrepresented) student population. Two classrooms from each of the three grade levels participated in the treatment (PBL), with each grade level divided into seven groups (eight to ten students in each group). In addition, two classes from each grade level participated in the control

group. Students in the treatment classes met in problem-based learning groups throughout the week to work on PBL units, with the PBL units representing about 2 percent of their total curriculum. The PBL units had students take on learning issues (or problem statements), conduct independent research, share their research with their classmates, and then put their findings together to make connections. Researchers found students – and teachers – had positive perceptions of problem-based learning, with a survey of 88 students showing they liked being accountable for what they learn. Researchers also collected data related to behavior, and among the cohort starting PBL groups in their sixth grade year, reported behavior ratings were 20 percent better for sixth-graders and 17 percent better for seventh-graders. Lastly, for the cohort starting PBL in sixth grade there were statistically significant higher science grades for the treatment group as compared to the control.

Reporting similar results related to motivation, but with Hong Kong University students, Downing, et al. (2009) explored how a problem-based learning approach impacted first-year undergraduates. Researchers assigned the treatment (problem-based instruction) to an intact group of students, and the control (traditional methods) to another intact group of students. Utilizing the Learning and Study Strategies Inventory (LASSI), a pre and post design was implemented. The LASSI includes 10 scales divided into three areas: skill, will, and self-regulation. Following the year-long program, the treatment group showed significantly higher scores on all 10 scales of the LASSI. The 'will' area of the LASSI, which includes motivation and attitude as scales, resulted in the greatest differential in means between the treatment and control groups.

Similarly, using the Motivated Strategies for Learning Questionnaire (MSLQ), Sungur and Tekkaya (2006) examined the impact of traditional instruction and problem-based learning

on student self-regulated learning. Using a pre- and post- design, authors examined two intact 10th grade classes with 61 students and the same biology teacher in Turkey, assigning one class to an experimental group and one to the control group. The MSLQ was utilized for data collection, focusing on a motivation section and a learning-strategies section. The motivation section includes six subscales in the areas of goals and value beliefs, beliefs about ability to succeed, and test anxiety; while the learning-strategies section includes nine subscales in the areas of metacognitive knowledge and regulation. Researchers concluded experimental and control groups had significantly different mean scores for the following subscales of the motivation section of the MSLQ (with experimental group scoring higher): intrinsic goal orientation and task value. For the learning-strategies section, the following subscales were reported as being statistically significant (with experimental group scoring higher): Elaboration, critical thinking, metacognitive self-regulation, effort regulation, and peer learning. Students in the experimental problem-based group tended to "participate in a task for reasons such as challenge, curiosity, and mastery" (Sungur & Tekkaya, 2006, p. 315).

Self-Reflection. In a review of literature, Schraw et al. (2006) discussed three self-regulative components – cognition, metacognition, and motivation – and examined how six different instructional strategies improved those components, one of which was inquiry-based learning. Citing Anderson (2002), Schraw et al. (2006) discussed three different forms of inquiry: scientific inquiry, inquiry learning, and inquiry teaching. The authors framed inquiry teaching as a process-oriented approach, structuring learning where students pose questions, work on solutions, and then test results. Schraw et al. (2006) postulated inquiry teaching promotes metacognition by actively engaging students, causing them to monitor their understanding (for example, self-reflection). Schraw et al. (2006) proposed three reasons inquiry-

based learning improves learning: (a) communication with experts who may share strategies or problem solving skills; (b) increased motivation as students share authority; and, citing Davis (2003), (c) it promotes self-reflection, a key component of metacognition. As part of the basis for Schraw's et al. (2006) argument of inquiry teaching promoting self-reflection, Davis (2003) utilized 178 middle school students to analyze the effect of generic and direct prompts on student reflection. While completing projects, students were given either a directed prompt or a generic prompt and were then tasked with completing the sentence. A generic prompt was not specific, while a directed prompt provided students with a hint of what to think about while reflecting. While student performance on the projects was not significantly different between the prompting conditions, students in "the generic prompt condition developed significantly more coherent understandings of science than did students who received directed prompts" (p. 129). As part of the author's conclusions, she stated "by engaging in productive reflection, students expand their repertoire of ideas and identify weaknesses in their knowledge, and then are more ready and able to link and distinguish their ideas" (p. 131). It was also concluded that autonomy may help students engage in reflection more.

Self-Directed Learning (SDL). Hmelo and Lin (2000) described SDL as being metacognitive, and includes examples such as students adapting and applying knowledge to new situations, and recognizing the need to learn more about a topic. While discussing problem-based learning in a medical school context, the authors suggested problem-based approaches support SDL development by being student-driven, having students attempt to solve problems, having students identify knowledge deficits, and by requiring students to self-evaluate and critique, among others. The authors continued, and offered students in a problem-based approach are

more likely to identify hypothesis-related learning issues, develop well-defined starting points, and integrate new ideas into their problem solving.

Similarly, in a review of literature, Blumberg (2000) suggested students in a problem-based approach demonstrate SDL skills, such as seeking information/resources and employing study strategies for deeper understanding. In her discussion of problem-based approaches and what students learn, Hmelo-Silver (2004) advised the research on inquiry-based approaches is somewhat mixed. Students may or may not perform evenly compared to traditional instruction on exams, but they may perform better than traditionally instructed students on elaboration abilities. The author went on to suggest problem-based approaches offered potential to help students become self-directed learners and flexible and reflective thinkers. In a similar vein, Hung, Jonassen, and Liu (2008), postulated self-control in the "learning process is essential for students to develop self-directedness in their own learning" (p. 494). This shines a light on the characteristic (student-driven) PBL and other inquiry-based approaches posit as critical.

Other areas of study with regard to metacognition and inquiry-based approaches include Seraphin et al. (2012), who explored metacognition as a way of increasing the effectiveness of inquiry-based approaches in science. Authors utilized a two-year professional development experience built on the Teaching Science as Inquiry (TSI) framework for science educators to increase their metacognitive strategies. The authors suggested it was common for both novice and seasoned teachers to be unfamiliar with metacognition at the start of the professional development, but teacher use and evaluation of metacognition increased as they progressed through the program. Also attempting to promote higher-order thinking, Cockrell, Caplow, and Donaldson (2000) studied university-level students engaged in a 6-credit problem-based learning

course. The authors found students progressively demonstrated greater "clarity in their reasoning, analysis, and problem solving skills" (p. 360).

Theoretical Framework

The model of teacher change was first presented by Guskey (1986). Guskey's model proposes that for teacher change to happen, four elements are needed: (a) professional development (PD); (b) change in classroom practice; (c) change in student learning outcomes; and (d) a change in teacher beliefs and attitudes. Guskey (2002) further elaborated on teacher change and growth, suggesting changes in attitudes and beliefs by teachers is focused more on student learning outcomes, than on themselves as teachers. Guskey went on to contrast the traditional model of teacher change, where PD is aimed at altering teacher beliefs and attitudes in hopes of affecting their practice, and ultimately, student learning outcomes. In the revised model, Guskey stated teacher change starts with PD aimed at changing teacher practice, thus possibly resulting in changes in student learning outcomes, and, ultimately, changes in teacher belief and attitudes. A model of teacher change is presented in Figure 2.2:

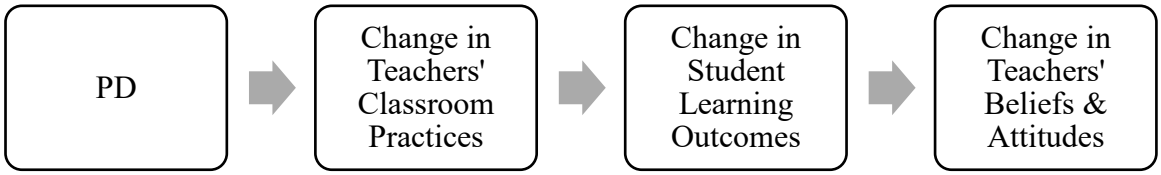

Figure 2.2 Model of Teacher Change (Guskey, 2002)

Guskey (2002) highlighted that PD in the new format (Figure 2.2), may encourage a change in teacher practice, such as a new instructional approach or new curricula – but a change in attitudes or beliefs by teachers does not occur until after the change in practice is supported by student learning evidence. Under the old model, the PD would be focused on gaining acceptance

or commitment from teachers before the new practices are even implemented. Further contrasting them, in the old model it is the PD that changes teacher beliefs and attitudes, while in the new model it is the successful implementation of practices that alters teacher beliefs and attitudes. However, the author acknowledged a potential over-simplification of teacher change, suggesting participants in PD must at least "change from cynical to skeptical for any change in practice to occur" (p. 385).

In support of the model, Guskey (2002) highlighted several other studies, including a study examining 146 school districts implementation of innovative teaching practices (Crandall et al., 1982). Citing Crandall, Guskey (2002) stated that in districts where managers tried to enhance teacher commitment by involving the teachers in decision-making prior to implementation, the practices lost their effectiveness because they were over-altered by teachers. Further, citing a 1984 article by Guskey, Guskey (2002) purported that the teachers who used a new mastery method of teaching and saw improvement in student learning (i.e., increased student course grades and scores on end of course exams), liked teaching more and believed they could influence student outcomes; but among teachers who saw no student results, no changes to their attitudes toward teaching were reported by researchers (Guskey, 1984). Thus, Guskey (2002) argued neither "training alone nor training followed by implementation was sufficient for affective change" (p. 386) – attitude and belief changes by teachers "occurred only when training and implementation were combined with evidence of improved student learning" (p. 386).

Guskey (2002) outlined three principles necessary to help teachers move through the Model of Teacher Change: (a) recognize change is gradual and difficult; (b) provide teachers with feedback on student learning progress; and (c) provide follow-up support and pressure. Change is difficult as teachers have a commitment to student learning, and what if the new

practices cause a drop in learning? This realization causes teachers to not easily discard current practices, and places importance on principle number two. Providing feedback helps teachers see student progress, allowing teachers to value the new practice and potentially alter their beliefs and attitudes. Similarly, support and pressure are important because Guskey (2002) suggested the most crucial elements in the teacher change process are after the PD event. Support minimalizes potential anxiety felt by teachers, and pressure gives a push to those who might not act on their own.

Teacher Perception of Metacognition during the Learning Process as Learning Outcome

In contradiction to the old model of teacher change – where the critical stage would be the necessary immediate change in teacher beliefs and/or attitudes as a result of a PD event – Guskey's (2002) revised model puts emphasis on teacher perception of student learning outcome change as the critical element required for sustained change in teacher practice. Offering support for Guskey's notion, Rogers (2007) reported findings from a case study examining one teacher's PD experiences for a year. Although offering a more cyclical model, Rogers (2007) supported Guskey's (2002) notion that teachers need to see positive student outcomes before having a change in beliefs and attitudes. Examining e-learning with Danish science teachers, Noesgaard (2016) also supported Guskey's notion. In other words, teacher attitudes/beliefs toward the content of their professional development experience are dependent on the student learning outcome change related to the PD topic. Guskey described the critical learning outcomes stage as any "evidence teachers use to judge the effectiveness of their teaching" (p. 384). Following the Model of Teacher Change, a teacher will collect evidence of student learning (student learning

outcomes) related to the practice change that emanated from the PD event before adjusting beliefs and/or attitudes.

Given the stated need for research focused on teacher perceptions of metacognition and the learning process during an instructional strategy, metacognitive PD would fit within the model of teacher change. The PD stage would be focused on metacognition, with the PD event moving teachers toward adjusting their practice to incorporate metacognitive strategies. Adhering to the Model of Teacher Change (Guskey, 2002), teachers would then observe student learning outcomes before deciding whether the change in practice (metacognitive instruction) was of benefit to their students. If teachers decide it is of benefit, they may adjust their attitudes and beliefs accordingly, possibly resulting in sustained change.

Summary

Metacognition was broken down into two components, metacognitive knowledge and metacognitive regulation (Flavell, 1979; Reeve & Brown, 1985). Jacobs and Paris (1987) later elaborated on metacognitive knowledge, suggesting it included three types of knowledge: declarative, procedural, and conditional. Metacognitive regulation was also defined by Brown et al. (1983) as being regulatory activities such as planning, monitoring, evaluating, and revising. An and Cao (2014) combined these two components of metacognition and organized them into a model which was presented in Figure 2.2.

Project-based Learning (PBL) was presented and juxtaposed with problem-based learning, a similar but separated instructional approach. Project-based Learning was then conceptualized to include five necessary elements: problem, investigation, artifacts, community, and cognitive tools (Krajcik et al., 1994). The benefits of PBL (and inquiry approaches to learning as a whole) to students were also discussed, and included increasing students'

motivation to learn (Gordon et al., 2001; Downing et al., 2009; Sungur & Tekkaya, 2006), promoting elaboration strategies and self-reflection (Davis, 2003; Schraw et al. 2006), and promoting self-directed learning (Blumberg, 2000; Hmelo-Silver, 2004; Hmelo & Lin, 2000). Lastly, the Model of Teacher Change (Guskey, 2002) was presented as the theoretical frame for the study, highlighting how the Model fit the purpose of the study.

Chapter 3 - Methodology

Purpose of the Study

This study sought to explore how teachers facilitate learning and perceive metacognition in a Project-based Learning (PBL) instructional environment after participating in professional development on metacognitive strategies.

Research Questions

1. How does knowledge of metacognitive strategies influence teacher perception of the learning process in a PBL instructional environment?
2. How do teachers facilitate student learning in a PBL instructional environment before and after metacognitive professional development?
3. What are educators' interpretations of student metacognitive regulation and knowledge during a PBL instructional environment?
4. How do teachers view their roles in influencing student metacognition?

Introduction

Chapter one discussed the merits and educational value of metacognition and PBL, as both are deemed valuable to student learning. I also explored the difficulties they both present to educators, as metacognition is often internal and not readily available for others to see (National Research Council, 2000), and needs to be taught explicitly by teachers (An & Cao, 2014; Schwartz et al., 2013; Thomas & Anderson, 2014; Zohar & David, 2008) who may not have an adequate understanding (Hughes, 2017; McKendree & Washburn, 2017; Seraphin et al., 2012). Similarly, PBL presents its own challenges in that teachers' and students' prior beliefs and attitudes toward learning may undermine implementation (Blumenfeld et al., 1991; Ladewski et al., 1994; Marx et al., 1997).

In chapter two I described the scholarship of metacognition, including its first mention as metamemory by Flavell and Wellman (1975). We discussed the structure of metacognition as it is widely accepted – a metacognitive knowledge component and a metacognitive regulation component – and presented a model (see Figure 2.2, Chapter 2). Next, PBL was introduced as a type of inquiry-based approach to instruction, and was juxtaposed with problem-based learning. The benefits of inquiry-based approaches such as PBL were explored by looking at research on inquiry-based approaches as a whole, as research has shown inquiry-based approaches (a) increase students' motivation to learn and interest in the subject matter (Downing et al., 2009; Gordon et al., 2001; Sungur & Tekkaya, 2006); (b) promote elaboration strategies and self-reflection (Davis, 2003; Schraw et al., 2006); and (c) promote self-directed learning (SDL) (Blumberg, 2000; Hmelo & Lin, 2000; Hmelo-Silver, 2004). Finally, the Model of Teacher Change (Guskey, 2002) was presented as the theoretical framework, focusing on the four stages Guskey purported as critical for a change in teacher practice: professional development (PD), change in classroom practice, change in student learning outcomes, and a change in teacher beliefs and attitudes.

Subjectivity Statement

As an agricultural teacher-educator and researcher seeking to explore how educators facilitate learning and perceive metacognition in a Project-based Learning instructional environment, I examined and detailed how my own interactions and prior experiences in education impacted my own meaning of the study. Despite early struggles academically, I was a strong academic student throughout late elementary and middle school. But my first interaction with consistent, constructive feedback came in the form of competing in Career Development Events as an FFA member. Those FFA and SBAE opportunities provided me with constructive

criticism from my agriculture teacher in order for me to become more proficient at the task. My relationship with my agriculture teacher also had a definite impact on my decision to enter the agricultural education field. As a result of these experiences, I have strong feelings about the impact SBAE and other Career and Technical Education programs can have on learners. Emanating from those feelings towards SBAE, as a teacher I have a strong sense of responsibility to my students. I assumed educators in this study shared similar beliefs concerning their diligence to students.

Previous opportunities to work with the teachers participating in this study has also impacted how I view and respect them as educators. I have known the six teacher-participants involved with this study for several years and view each of them as proficient educators. These prior relationships have the potential to cause me to assume the best regarding teacher-participants' discussions of pedagogical decision-making.

I have generally believed myself to have effective study habits as a student. In high school and into college I can recall monitoring my studying environments, pre-planning what I was going to study and for how long, and seeking help from others. However, I did not know of a label to assign to these habits or how they were related to metacognition. I also do not recall where exactly I learned them, although I am sure some were explicitly taught to me. My resulting assumption is that, currently, most metacognitive strategies are taught implicitly rather than explicitly in public education – if those strategies are taught at all. My usage of metacognition as a student has carried over into my work as a professional. I always reflect on lessons and daily events as a teacher, often looking to improve my instruction and seek advice from other more experienced teachers.

While not knowing the term for these strategies I have used was "metacognition," I viewed them as important and beneficial to my growth. As a teacher, I feel as though I utilized metacognitive processes well, but I did not provide explicit instruction on these strategies to students. Through reflection on my teaching I realize the opportunities I had, but did not take advantage of, as a SBAE teacher to incorporate metacognition into my instruction. I also feel other educators have opportunities to teach metacognition explicitly to their students, helping to increase metacognitive abilities in struggling and successful students alike.

Philosophical Overview

Teaching and learning are embedded in interactions and human experiences of teachers and students. This study sought to interpret teachers' awareness and facilitation of metacognition in a PBL environment while moving through the Model of Teacher Change (i.e., before and after a professional development experience, and before and after observing potential changes in learning outcomes with students) (Guskey, 2002). Focusing on the teacher-participants' meaning-making of metacognitive processes aligns this study with an interpretivist approach. Specifically, this study utilizes a symbolic interactionism lens, as symbolic interactionism has three assumptions:

- human beings act toward things on the basis of the meanings these things have for them;
- the meaning of such things is derived from, and arises out of the social interaction one has with one's fellows;
- these meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things he encounters. (Blumer, 1969, p. 2)

Based on these three assumptions, research using the symbolic interactionism approach should focus on the ways in which individuals make meaning of their experiences, by trying to "reconstruct the subject's viewpoints" (Flick, 2009, p. 58). Similarly, Stryker (1976) suggested "the fundamental methodological principle of symbolic interactionism [is] researchers have to see the world from the angle of the subjects they study" (p. 259).

The present study aimed to interpret teacher-participants' attitudes and beliefs towards the learning process and metacognition as they moved through the stages of the Model of Teacher Change. Given Guskey's (2002) suggestion that teachers don't experience a change in attitude and beliefs immediately following a professional development (PD) experience, how teacher-participants in this study experienced the stages of the Model of Teacher Change after a metacognitive PD was of great interest. Symbolic interactionism allowed the researcher to reconstruct the participants' viewpoints during each stage of the Model of Teacher Change (before metacognitive PD, after PD, and after implementation of two PBL curriculum units). In addition to focusing on the teacher-participants' progression through the Model of Teacher Change, symbolic interactionism also aided the researcher in reconstructing how participants make meaning of metacognitive processes in their students.

Both the theoretical frame (Model of Teacher Change) and the philosophical framework (Symbolic Interactionism) were chosen based on their alignment with the driving research questions in this study. As the first research question asked, teacher-participant experiences potentially impacted how he/she perceive the learning process as it relates to metacognition and PBL instructional environments. Teacher-participants' meaning-making was further explored by question two, which sought to reconstruct how they facilitate learning as it relates to metacognition and PBL. With these questions being investigated while teacher-participants'

move through the Model of Teacher Change, symbolic interactionism lent itself well to understanding teacher-participants' perspectives and meanings appropriated to metacognition, PBL, and the learning process – as teacher perspectives were gathered before and after they underwent metacognitive professional development, and before and after they implemented the PBL curriculum.

Correspondingly, both questions three and four relied on a symbolic interactionism approach for similar reasons. Question three sought to reconstruct how teacher-participants made meaning and interpreted the metacognitive thinking by of their students while in a PBL environment. Filtering teacher-participants' meanings through the Model of Teacher Change further strengthens the applicability of an interpretivist approach, as Stryker (1976) suggested "when a person defines a situation as real, [the] situation is real in its consequences" (p. 259). Meaning, how teacher-participants view student-use and success of metacognition impacted how those teachers further perceived the value of continuing metacognitive-oriented instruction. If teacher-participants' perceptions and viewpoints do not support the value of metacognition, they likely will not achieve the final stage in the Model of Teacher Change, which is a change in beliefs and attitudes.

Background

Seeking a curriculum resource that fits both the parameters of PBL and offers an opportunity to utilize educators who have received professional development related to said curriculum, the *Food and Nutritional Sciences* (FNS) curriculum was chosen. It was developed in a joint project by the University of Nebraska-Lincoln (UNL), Kansas State University (KSU), and the Nebraska Department of Education (NDE). The FNS curriculum was an outcome of a larger grant project titled *The Reduction of Shiga Toxin-producing E. coli in the Beef Food Chain*

Coordinated Agricultural Project (STEC CAP). A significant portion of the STEC CAP grant funding, the development of food science/safety curriculum materials for utilization by high school teachers, was one of the main educational and outreach activities of the grant. The goal of the curriculum, teaching proper food handling techniques to students so that they can take those techniques home to their parents, was similar to the origins of 4-H and its early roots in corn and canning clubs.

The FNS Institute Series was an outcome from the FNS curriculum. They were curriculum workshops for secondary science, school-based agricultural educators (SBAE), and family and consumer science (FACS) teachers held during the summers from 2013 until 2017. The FNS Institute focused on instruction in PBL while delivering training on food science concepts needed to teach the FNS curriculum. In early iterations (2013, 2014), the Institute served as both a teacher training event and a medium through which to acquire teacher feedback for curriculum revisions. Teachers were asked to attend the workshop, receive PBL and food science training, teach some (or all) of the curriculum, and then provide in-depth feedback to curriculum writers. After the FNS courses were more fully developed, the Institutes evolved to more of an outreach activity for the STEC CAP grant, training teachers on PBL and the FNS curriculum in hopes of curriculum implementation in their respective schools. FNS Institutes were delivered in a model where focus is placed not only on content but also on instructional strategies.

Given the availability of curricular materials and the already-completed professional development of educators, the FNS Institute series serves as the population from which participants were invited to participate in the study. Approximately 85 educators from Kansas, Nebraska, and Florida participated in at least one FNS Institute between 2013 and 2017.

Participants

To enhance the trustworthiness of the study, eight was the targeted number of participants. After invitations were sent out, nine teachers agreed and were selected by the researcher to participate in the study. All nine of the teachers had undergone comprehensive professional development in PBL during the FNS Institute series, with each educator having participated at least one time. Educators were invited to participate via an email from the researcher (see Appendix A), followed up with a conversation. Selection criteria were minimal, as selected educators had to have completed at least one FNS Institute PBL professional development, had to be willing to complete online and in-person metacognitive professional development during the summer of 2018, and had to be willing to teach two units of the PBL FNS curriculum with complete fidelity in the Fall of 2018. Past participants from the FNS Institute series provided an excellent population as those educators had already been trained on PBL and a common curriculum resource (FNS curriculum).

Past FNS trainings for the teacher-participants included instruction on teaching with a PBL approach. Project-based learning instruction was based on the Krajcik et al. (1994) five elements of PBL: (a) engage students in solving an authentic problem, with the problem helping to structure the learning that will take place; (b) problems result in the creation of artifacts or products; (c) allows for investigation; (d) develops a community of inquiry (i.e., students, teachers, and community members); and (e) promotes cognitive tool use by students (i.e., technology integration). This PBL instruction was a component of each FNS Institute, and involved one full day devoted to discussing the five Krajcik et al. (1994) PBL elements. Additionally, as each FNS Institute progressed, content facilitators made reference back to the

five PBL elements. Having participants with this PD experience should result in increased fidelity of curriculum implementation.

After recruiting with the intent to include at least eight participants, nine teachers initially volunteered for tor the study. Because of this, the final number of participants selected to participate was set at nine so as to include multiple perspectives. Those multiple perspectives included educators from different disciplines (SBAE and FACS), different regions in Kansas/Nebraska, and different experience levels (i.e. years of teaching). The initial recruitment target was set at eight to allow the researcher to understand the phenomenon more thoroughly throughout the study, providing an assumed excess of data to ensure saturation with protection against participant drop out. Table 3.1 shows the demographic breakdown of the nine selected teacher-participants for this study. To protect teacher-participants' anonymity, names displayed are pseudonyms.

Table 3.1 *Participant Demographic Breakdown*

Participant	Teaching Field	State of Employment	Number of FNS Workshops Attended	Years of Experience in Teaching
Andrea	SBAE	Kansas	2	6
Anita	SBAE	Kansas	4	8
Cindy	SBAE	Nebraska	3	8
Gabby	SBAE	Kansas	2	17
Jamie	Science	Kansas	4	18
John	SBAE	Kansas	1	20
Mike	SBAE	Kansas	1	25
Nina	FACS	Kansas	1	25
Tim	SBAE	Kansas	2	33

Note. Pseudonyms were assigned based on gender and years of teaching experience. Years of experience in teaching was self-reported by teacher-participants. However, exact years of

teaching experience for Anita, Jamie, and John are estimates as they withdrew from the study before those data were collected by the researcher.

Of the nine participants in the study, all nine completed the first round of interviews that were conducted over Zoom during the months of June and July 2018. However, three teacher-participants did not complete the metacognitive professional development, citing time constraints and other responsibilities as reasons for withdrawing from the study. All six of the remaining teacher-participants completed the metacognitive professional development, and the subsequent second and third rounds of interviews. Table 3.2 displays teacher-participant completion details with each identified by the pseudonyms used throughout the study.

Table 3.2 *Participant Completion Details*

Participant	Interview 1	Online Metacognitive Modules	In-Person Metacognitive PD	Interview 2 and 3	Curriculum Implementation	Student Artifact
Anita	✓	Withdrew				
Jamie	✓	Withdrew				
John	✓	Withdrew				
Andrea	✓	✓	✓	✓	✓	✓
Cindy	✓	✓	✓	✓	✓	✓
Gabby	✓	✓	✓	✓	✓	
Mike	✓	✓	✓	✓	✓	✓
Nina	✓	✓	✓	✓	Partial	
Tim	✓	✓	✓	✓	✓	✓

Note. Nina completed all interviews, but was unable to implement the curriculum. Gabby implemented the curriculum and completed all interviews, but did not provide student artifacts.

Metacognitive Professional Development

A professional development on metacognition was created by the researcher to increase teacher-participants' awareness of, and ability to facilitate, metacognitive strategies. The PD was reviewed by two outside experts in metacognition, and was comprised of two elements, an online set of modules and an in-person training. The online element was made available to teacher-participants via the KSU Canvas system after the first round of interviews. Each module (three

total) included a researcher-narrated PowerPoint video lecture and optional discussion questions, and modules one and two included readings. Teacher-participants then had two weeks to complete the online modules before participating in an in-person training held at KSU on August 1 from 8:00 a.m. until 3:00 p.m.

Online metacognitive PD was structured following the two components of metacognition posited by Brown et al. (1983) and Jacobs and Paris (1987): metacognitive knowledge and metacognitive regulation. The first module focused on metacognitive knowledge, and included explanation and examples of declarative, procedural, and conditional knowledge (see Appendix B). Module number two concentrated on metacognitive regulation, with explanation and examples of planning, monitoring, evaluating, and revising activities. Lastly, the third module described the importance of metacognition, citing potential benefits of facilitating metacognition with students. Table 3.3 details the total amount of time each participant spent completing the modules on Canvas.

Table 3.3 *Time Participants Spent on Online Metacognitive Modules*

Participant	Time in Hours:Minutes:Seconds
Andrea	1:40:19
Cindy	2:26:42
Gabby	1:52:50
Mike	2:27:54
Nina	1:10:03
Tim	1:06:34

Note. Tim completed the online modules the day before the in-person PD under the guidance of the researcher due to technological difficulties.

The second element of the researcher-developed metacognitive PD was an in-person training. The in-person PD concentrated on further helping teacher-participants make meaning of metacognition and challenged them to consider how they would attempt to facilitate metacognitive strategies with students (see Appendix C). The in-person training was built around

Schraw's (1998) four ways to facilitate metacognition: (a) promoting awareness; (b) improving metacognitive knowledge; (c) improving metacognitive regulation; (d) and fostering conducive environments. Each of the respective four foci included a reading and discussion followed by practical application.

First, promoting awareness had teacher-participants discuss what subject-specific metacognition may resemble within their classes. Next, teacher-participants read and discussed two articles introducing them to metacognition, one highlighting ten metacognitive strategies to utilize with students, and another highlighting the promotion of metacognition within a biology classroom – specifically referencing planning, monitoring, and evaluating self-questions for students to answer during a course. Lastly, teacher-participants applied the knowledge by writing one metacognitive activity into the two PBL curriculum units.

Next, improving metacognitive knowledge entailed discussion on a strategy evaluation matrix (Schraw, 1998). A strategy evaluation matrix is a teacher and/or student-created matrix that lists learning strategies, including details of when, how, and why to use each strategy. The strategy evaluation matrix is a way to promote declarative, procedural, and conditional metacognitive knowledge (Schraw, 1998) among students and students can continuously add to it as they encounter more learning strategies. During this focus of the PD, teacher-participants created a strategy evaluation matrix collectively, centered on strategies that could be employed by students who are completing the two PBL curriculum units.

The third focus was on improving metacognitive regulation, and involved teacher-participants discussing a regulatory checklist. Regulatory checklists are a way of improving metacognitive regulation (Schraw, 1998) by listing self-guiding questions for students to answer during an assignment or learning activity. Regulatory checklists can include planning,

monitoring, and/or evaluating questions. For example, a monitoring question may be "does the task make sense?" After a brief discussion, teacher-participants created a regulatory checklist for use specifically within the two PBL curriculum units.

The final focus of the PD centered on fostering metacognitive environments. Specifically, teacher-participants discussed ways to make the learning environment more metacognitively conducive by re-examining thoughts on learning and one's ability to change as a learner. The session included a discussion of whether mental ability is a fixed asset, and the role of locus of control within learning. Teacher-participants then read and discussed an article highlighting seven ways to promote general metacognitive environments with students.

It should be noted that two teacher-participants, Andrea and Cindy, were unable to attend the in-person metacognitive PD. However, they completed a live PD with the researcher via video conferencing software. The video conferenced PD was identical in structure to the in-person PD, including the same discussion prompts, readings, and application activities. Video conferenced PD participants contributed to the same resources that were created during the in-person PD (i.e., strategy evaluation matrix and regulatory checklist), in addition to creating their own resources (i.e., writing a metacognitive activity into one of the two PBL units).

At the conclusion of the in-person PD, teacher-participants were given a Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994). Teacher-participants' respective inventories were collected by the researcher and scored using a modified MAI scoresheet ("Metacognitive Awareness Inventory," n.d.). Each of the 52 items on the MAI correspond with either metacognitive knowledge (17 items) or metacognitive regulation (35 items). For each item participants mark a 'yes' or 'no,' indicating whether they enact that strategy during a learning event, with a 'yes' representing one point and a 'no' representing zero points. Total points were

then tallied to provide a metacognitive regulation and metacognitive knowledge total score for each teacher-participant. Appendix D lists each MAI item as well as corresponding teacher-participant responses. Table 3.4 depicts teacher-participants' self-reported scores for metacognitive knowledge and regulation at the conclusion of the in-person metacognitive PD.

Table 3.4 *Participant Scores on the Metacognitive Awareness Inventory*

Teacher-participant	Metacognitive Knowledge (17 possible)	Metacognitive Regulation (35 possible)	Total (52 possible)
Andrea	16	24	40
Cindy	11	22	33
Gabby	16	19	35
Mike	17	32	49
Nina	11	25	36
Tim	11	22	33

Method

Overview

Following Flick's (2009) suggestion, a series of three semi-structured interviews were employed as interviewees' viewpoints are "more likely to be expressed" (p. 150) (see Appendix E for complete interview protocols). Data collection was in-depth and followed an interpretivist approach, allowing the researcher to understand participants' meaning making "as mediated through the researcher as instrument" (Merriam, 2002, p. 6). The semi-structured format allowed greater sharing by participants than in a more standardized interview (Flick, 2009), but still provided structure to the interviews. Participants were asked to implement two units of PBL curriculum (i.e., *Food for Thought* and *Beef it's what's for Dinner*) into one class of their choosing. In addition, as a form of triangulation, the researcher also collected student-created

artifacts from teacher-participants. The artifacts were used to further support or question data derived from teacher-participant interviews. Figure 3.1 outlines the research design of the study:

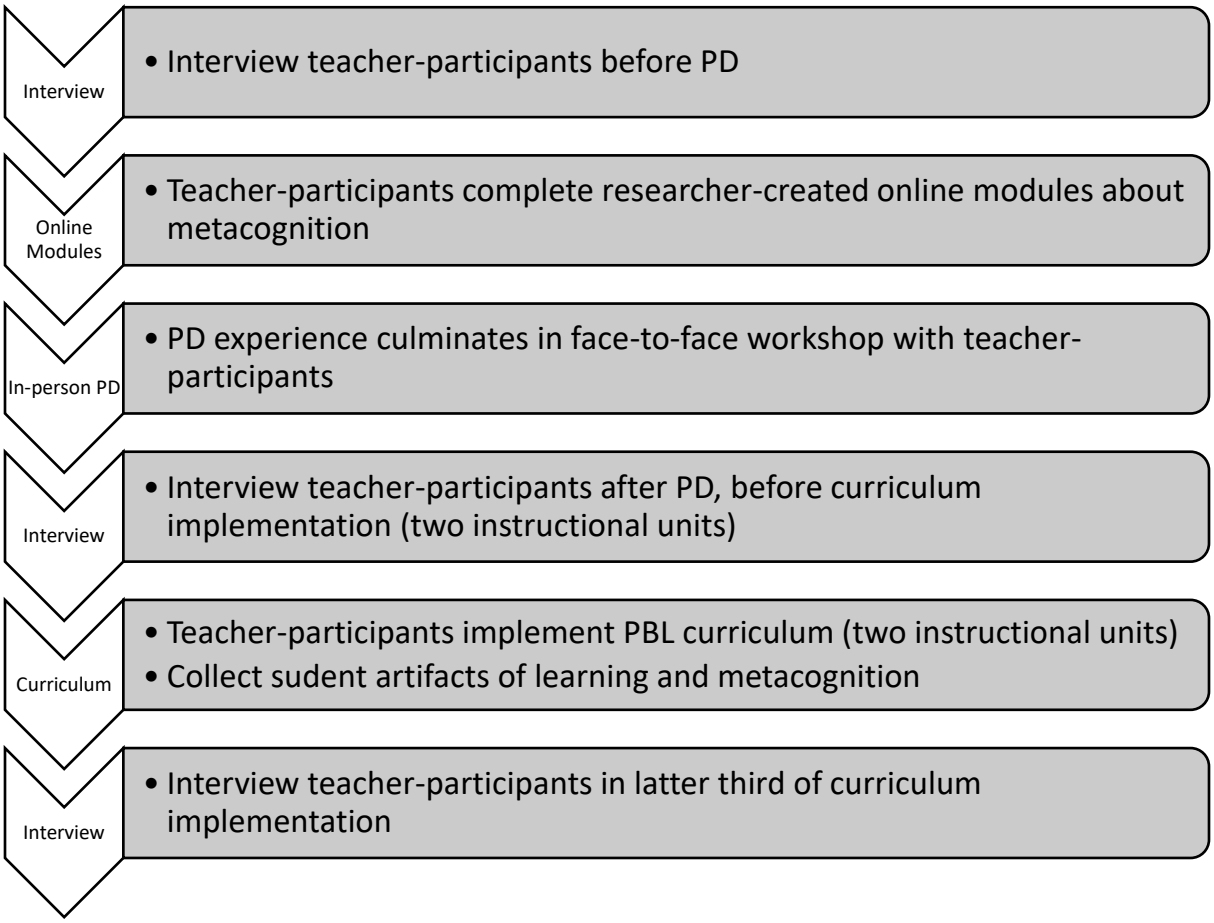

Figure 3.1. Research Design

Data Collection

Semi-structured interviews were conducted in a variation of the Seidman (2013) technique. In the Seidman technique a series of three, 90-minute interviews are conducted, with each interview focusing on a slightly different theme. The researcher utilized a list of primary questions and follow-up probing questions that were developed in advance of the study. This provided a guide for the interview, but still allowed for the interview to be adapted to better understand the participant's perspective. Specifically, interview protocols addressed: (a) teacher-

participants' understanding and beliefs on the learning process before and after PD; (b) teacher-participants' feelings toward metacognition and students; (c) teacher-participants' perceptions of students' ability to utilize metacognition; (d) teacher-participants' perceptions of how they facilitated metacognition; and (e) teacher-participants' perceptions of the benefit of metacognition (see Appendix E for full protocols).

The first interview in the Seidman (2013) series involved putting the participant's experience into context. Next, the researcher focused on reconstructing the participant's experiences within the previously noted context in which those experiences occurred. Lastly, the third interview encouraged participants to reflect on the meanings of their experiences. An adaptation of this model was utilized by having one interview before teacher-participants participated in metacognitive PD, one interview after the metacognitive PD, and the third interview after implementation of two units of PBL curriculum.

In Seidman's (2013) technique, the first interview focuses on developing a frame through which participants make meaning of their world. In this study, the first interview was used to interpret how teacher-participants view learning within a PBL class. Establishing the context of learning beliefs and attitudes of teacher-participants allowed the researcher to gain insight into how participants made meaning of both metacognition and PBL instruction. The intended aim of the first interview in the Seidman technique aligned well with the need in this study to establish a baseline of teacher-participants' beliefs about the learning process. This baseline aided the researcher in interpreting participants' experiences with metacognition as those participants moved through the Model of Teacher Change.

According to Seidman (2013), the second interview should focus on reconstructing experiences within the context they took place. The adapted model for this study focused on

reconstructing teacher-participants' viewpoints of metacognition and learning after having participated in a metacognitive PD. The second interview explored how exposure to metacognitive PD influenced teacher-participants' perceptions of the learning process in a PBL environment. This interview was situated between the PD and curriculum implementation (i.e., after phase one of the Model of Teacher Change). This interview represented the biggest deviation from the Seidman technique, as the researcher introduced a professional development that added a layer to the study. However, the adapted second interview still fulfilled Seidman's intended main purpose of reconstructing participant experiences (i.e., teacher-participant perceptions of the learning process in a PBL environment).

Finally, the third interview in Seidman's (2013) technique involves the participant reflecting on the meaning of their experiences. This was done by framing the interview to focus on how teacher-participants' experiences in the Model of Teacher Change impacted their beliefs and attitudes towards metacognition and PBL. This interview sought to understand how participants made meaning of metacognition after having completed a PD and implemented a two-unit PBL curriculum, thus rounding into focus the researchers' interpretation of participant experiences with, and beliefs about, metacognition.

To help the researcher reconstruct participants' viewpoints, approximately 45 to 60 minute semi-structured interviews were used. Seidman's (2013) recommendation is for 90 minute interviews, but it is implied this is a flexible guideline that the researcher can alter to better suit the study. For this study, the researcher-developed interview guide fit within an hour time block. While Seidman recommends spacing the interviews seven to ten days apart, the design of this study mandated the interviews were further apart than that timeline. Interviews were approximately two months apart, with the first taking place during the summer (June)

before any metacognitive PD, the second after the PD but before curriculum implementation (July/August), and the third after curriculum implementation (October to January).

In order to accommodate teacher-participants' schedules and account for the researcher's location, interviews were conducted via computer enabled face-to-face Zoom conferences – Flick (2009) suggested online interviews may be a choice when distance presents a challenge to data collection. Each interview was done independently with each participant, and followed a semi-structured technique with pre-determined open-ended questions and follow-up probing questions. In addition to recording the interviews through the Zoom software, an electronic recording device was used during each interview to ensure precise transcription of data. All data transcription was completed by the researcher, with aid of a free software (i.e., Otter).

Triangulation. As a form of triangulation, artifacts created by students during the PBL curriculum were also collected by the researcher. These artifacts were derived from researcher-created metacognitive prompts embedded into the PBL FNS curriculum. Each of the two units (i.e., *Food for Thought* and *Beef it's what's for Dinner*) from the FNS curriculum contained two writing prompts (see Appendix F) that required students to reflect on their learning during that unit of instruction, providing the researcher with insight into their metacognitive thinking. Each writing prompt contained four questions: two questions targeting metacognitive knowledge elements (i.e., one question on declarative knowledge and another on conditional and procedural knowledge), and two other questions geared toward metacognitive regulation (i.e., planning and monitoring, evaluating, and revising). Teacher-participants collected the artifacts, removed any identifiable information, and submitted them to the researcher for analysis. The number of student writing prompts submitted by each respective teacher-participant is displayed in Table 3.5.

Table 3.5 *Number of Artifacts for Each Curricular Unit Submitted by Teacher-participants*

Participant	Food for Thought Prompt 1	Food for Thought Prompt 2	Beef, it's what's for Dinner Prompt 1	Beef, it's what's for Dinner Prompt 2
Andrea	8	8	8	10
Cindy	0	0	6	7
Gabby	0	0	0	0
Mike	9	0	5	10
Nina				
Tim	9	7	16	0

Curriculum fidelity. To ensure fidelity of curriculum implementation, participants were asked to record their PBL class using a Swivl device. Swivl is a docking station that works with another device (e.g., tablet or smart phone) to track and record teacher movements and voice. Participants were provided a Swivl during the in-person metacognitive professional development and instructed on how to operate it. Teacher-participants created an account with Swivl where recordings would be stored in a 'cloud.' Participants were prompted throughout the study by email and text message to record their PBL class. Upon completion of the study, the researcher reviewed a pre-determined length of video recordings from each respective participant to ensure fidelity of curriculum implementation. Due to the variation in frequency and length of videos submitted by teacher-participants, the researcher reviewed five videos for each teacher-participant, evenly spaced throughout the videos submitted (e.g., if a participant submitted 32 videos, the researcher selected video 1, 8, 15, 22, and 29 for review.) To ensure even review, each of the reviewed videos were viewed at five minute intervals for one minute (e.g., if a video were 27 minutes in length, the researcher viewed one minute of video at the 1, 6, 11, 16, 21, and 26 minute mark). Table 3.6 displays the number of days recorded by teacher-participants, average length of videos, and the composite fidelity score based on the rubric described further below. Teacher-participants were encouraged, and reminded, by the researcher to record their

PBL class sessions. However, due to technical issues and personal preferences, some video recordings were more complete than others.

Each video selected was scored following a researcher-created rubric (Appendix G) to determine fidelity of curriculum implementation. The fidelity rubric aligned with the principles of PBL posited by Krajcik et al. (1994), and included the following criteria: students engaged in an authentic problem, evidence of artifact creation, evidence of investigation by students, evidence of a community of inquiry. The researcher did not retain the fifth element, cognitive tool usage, as technology integration has become a more widely accepted practice in the time since Krajcik et al. (1994) proposed its necessary inclusion. Each element was given a binary score (i.e., 0 for not present or 1 for present), and then the scores were totaled for each respective video review. The researcher determined a mean composite fidelity score of 2.5 or higher was emblematic of curriculum fidelity by that teacher-participant. It was postulated by the researcher a score of 2.5 or higher signified that teacher-participants were adhering to a majority of the Krajcik et al. (1994) criteria of PBL, and thusly were following a PBL approach. Appendices H, I, J, and K provide detailed fidelity scores for teacher-participants, while Table 3.6 details composite scores for fidelity videos for each teacher-participant.

Table 3.6 *PBL Curriculum Fidelity Check Times and Results*

Participant	Number of Videos	Number of Days Recorded	Average Length of Video	Selected Videos for Review	Mean Fidelity Score
Andrea	25	24	36.41 minutes	1, 7, 13, 19, 25	3.58
Cindy	30	27	41.09 minutes	1, 8, 15, 22, 29	3.59
Gabby	Researcher was not able to access Swivl account				
Mike	10	7	14.55 minutes	1, 3, 5, 7, 9	2.85
Nina	Was not able to complete curriculum				
Tim	10	7	17.38 minutes	1, 3, 5, 7, 9	2.71

Trustworthiness

To increase credibility and confirmability, member checks and audits were completed after transcription. Member checks were completed by emailing the transcribed text to each participant, allowing him/her to review the data and determine if its contents are accurate and representative of his/her feelings. Member checks are a form of communicative validation, or trustworthiness (Flick, 2009). In addition, the researcher's major professor conducted auditing of themes, categories, codes, and notes periodically to cross-check analyses, thus increasing the dependability of the research (Flick, 2009). Guba (1981) also suggested audit trails increase the stability (dependability) and confirmability of research findings.

Guba (1981) further elaborated on trustworthiness in broader research, suggesting it contains four necessary elements: credibility, transferability, dependability, and confirmability. Member checks are one way to develop the first element, credibility (Guba, 1981). This is done by testing findings "with the various sources…from which data were drawn" (p. 80). Next, Guba discussed transferability and how qualitative research seeks to form working hypotheses that may be transferred from one context to another, depending on the fit between the contexts. Guba further postulated dependability is developed through trackability and the researcher documenting actions, like audits and journaling. Lastly, when discussing confirmability, the author suggested qualitative research shifts the "burden of neutrality" (p. 81) from the researcher to the data.

Data Analysis

Glaser postulated qualitative analysis is generally approached in one of two ways: (a) by converting qualitative data into a crude quantifiable form as to test hypotheses (done by systematic coding followed by analysis); or (b) by inspecting the data for new properties of the

researcher's theoretical categories, so new concepts or theoretical ideas can be generated. Glaser combined the two approaches and suggested a third alternative, the constant comparative method. The constant comparative method utilizes the explicit coding procedures of the first approach and the theory development of the second, as Glaser stated it is "concerned with generating and plausibly suggesting…many properties and hypotheses about a general phenomenon" (p. 438). Analyses of data followed the Glaser (1965) constant comparative method.

The constant comparative method is done through four stages: (a) comparing incidents to categories; (b) integrating categories and their properties; (c) delimiting the theory; and (d) writing the theory (Glaser, 1965). While the process is presented in linear fashion, Glaser suggested it is accomplished non-linearly and all stages "remain in operation throughout the analysis" (p. 439). During the first stage the researcher compares incidents to categories, as theoretical properties of each category begin to emerge. The researcher's coding will then begin to shift from comparing "incident with incident to [comparing] incident with properties" (Glaser, 1965, p. 440). In between the first two stages it is important for the researcher to record memos concerning emerging themes and theories, and reflect on these ideas. The researcher then begins to delimit the theory into fewer, higher level concepts "based on underlying uniformities in the original set of categories" (Glaser, 1965, p. 441) and properties. Finally, in the last step in the process the researcher will engage in writing the theory. This is done with aid from the memos, which provide guidance on the major themes of the theory.

Limitations

Semi-structured, in depth interviews are a quality technique for understanding the depth of an answer to question(s); they also allow the researcher to gain deep insight into the feelings

behind that answer in order to reconstruct the participant's viewpoint (Flick, 2009). In addition to the small sample and non-randomized selection of participants, the nature and intent of qualitative research prohibits generalizing findings. Other limitations may apply, such as:

1. According to Bhattacharya (2008) one potential drawback to symbolic interactionism is the possible neglecting of hierarchies. This is due to symbolic interactionism seeking to perceive the world as the participant perceives it, as opposed to other philosophical views that may seek out and/or account for those possible hierarchical power struggles. These power struggles could potentially be a contributing factor to metacognition and PBL that goes unexplored. Considering the field of education has a hierarchical structure, a teacher's willingness to implement new strategies may be impacted by his/her perceived sense of autonomy in the classroom – but he/she may not recognize this as a factor or may not be willing to discuss it.
2. Answers to questions in the semi-structured interview protocols are self-reported by the teacher-participants, which may cause disparity between what is reported and what it actually carried out in instruction or personal reflection.
3. Following the Model of Teacher Change (Guskey, 2002), student receptiveness and success related to PBL and metacognitive instruction may impact the amount of emphasis teachers place on this instruction.
4. Artifacts of student work may not represent students' true attitudes or thought processes, but rather their interpretation of the "correct" response.
5. Class sizes varied for the participants, which may have impacted the fidelity in implementing the curriculum units.

6. The word “metacognition” was not used by the researcher during the first rounds of interviews. This was purposefully omitted so as not to lead teacher-participants in their responses to interview protocol questions. However, the omission of metacognition explicitly from the first interview may have impacted how teacher-participants answered questions. Their answers, and perceived knowledge of metacognitive strategies, may have been represented differently had further context been provided (i.e., explicit mention of metacognition).

Summary

The researcher used symbolic interactionism as a philosophical overview to explore how educators facilitate learning and perceive metacognition in a PBL instructional environment after participating in professional development on metacognitive strategies. This philosophy enabled the researcher to gain the perspectives of participants, by reconstructing their experiences. A three-interview series following the Seidman technique (Seidman, 2013) and using a semi-structured approach was employed to gain the perspective of participants. The semi-structured approach to interviews allowed for flexibility while also creating guidelines and structure (Flick, 2009), while the Seidman technique helped the researcher put participant’s experiences into context and was adaptable to the Model of Teacher Change.

To maintain trustworthiness and gain a more comprehensive understanding of multiple viewpoints, nine participants were included in this study at the start. Participants were selected from past completers of FNS Institutes as to allow for participant familiarity with PBL and thus increasing curriculum fidelity.

Chapter 4 - Results

Introduction

The purpose of this study was to explore how educators facilitate learning and perceive metacognition in a Project-based Learning instructional environment before and after participating in professional development on metacognitive strategies. At the conclusion of the transcription process, there were 167 pages of single-spaced text included in the data analysis process. Data were then analyzed following the constant comparative method (Glaser, 1965).

Due to the natural break in data (because of the professional development between the first and second interview), the researcher conducted two separate data analyses. In order to gain teachers' perceptions of the learning process in a PBL environment before the metacognition professional development, the first round of interviews were coded and results were written before analysis was initiated for the second and third round of interviews. After completing the first round coding process and preparing results, the researcher analyzed the second and third round interviews using the constant comparative method before proceeding to preparation of the results. Consequentially, this chapter will have four main sections: (a) a section describing the triangulation data collected and the procedures used to analyze said date; (b) a section describing the teacher-participants; (c) a section focused on the narrative of themes from the first round of interviews; and (d) a section focused on the narrative of themes from the second and third rounds of interviews.

Triangulation

As a form of triangulation, student writing prompts for each of the two PBL units were developed by the researcher as described in Chapter three. Analysis of the student artifacts was done by the researcher with the aid of a rubric that followed the model of metacognition

presented in chapter two (see Figure 2.2). The rubric (see Appendix L) incorporated elements of metacognitive knowledge and metacognitive regulation, allowing the researcher to get a more complete perspective of students' metacognitive usage. Parsing out metacognition into individual smaller elements postulated in the model further enabled the researcher to gain a deeper understanding of students' self-described application of metacognitive strategies. Scoring of the writings was on a point scale, with six points possible for metacognitive knowledge elements and eight points possible for metacognitive regulation elements.

Further insight into students' metacognitive usage at four distinct times during the two-unit curriculum enabled the researcher to cross-check student self-reporting with that of their respective teacher. For instance, a teacher-participant may have self-reported during the third interview they facilitated metacognitive activities with students and students displayed metacognitive thinking – but if students' writings do not support this notion, the teacher-participant's understandings or facilitation attempts of metacognition may not be accurate. Table 4.1 displays the means for each writing prompt (i.e., artifacts) for each teacher-participant. For a detailed review of each student writing artifact score, see Appendices M through P.

Table 4.1 *Metacognitive Knowledge and Regulation Means for Student Writing Artifacts*

Participant	Food for Thought Prompt 1 Means	Food for Thought Prompt 2 Means	Beef, it's what's for Dinner Prompt 3 Means	Beef, it's what's for Dinner Prompt 4 Means
Andrea	2.57/3.29	0.63/3.63	1.63/3.75	1.10/3.70
Cindy			2.60/4.20	1.29/3.71
Gabby				
Mike	1.63/2.25		1.80/3.40	0.75/2.63
Nina				
Tim	2.33/2.67	1.71/3.00	3.06/3.93	

Note. Means are displayed as Metacognitive Knowledge mean / Metacognitive Regulation mean. Knowledge means are out of six possible points and Regulation means are out of eight possible points. Missing scores indicates student writings were not submitted by that teacher-participant.

Description of Participants

A brief description of teacher-participants is provided below to provide more detail of participants' background. Pseudonyms are used in order to maintain confidentiality of participants. Pseudonyms correspond with gender of participants, as well as experience range. Pseudonyms earlier in the alphabet (e.g., Cindy) signify a less-experienced teacher compared to one further in the alphabet (e.g., Nina).

Andrea

Andrea has been teaching for six years. She earned a Bachelor's and Master's degree in Agricultural Education, and currently teaches at a small, rural junior/senior high school with an approximate enrollment of 80 students. She has roughly 40 students in her program, and her course load consists of exclusively agricultural education classes.

Cindy

Cindy has been teaching for eight years. She earned a Bachelor's degree in agricultural education and currently teaches at a small, rural high school with a total enrollment of approximately 300 students. She has about 40 students in her program, and her course load consists of exclusively agricultural education classes.

Gabby

Gabby has been teaching for 17 years. She earned a Bachelor's degree in Agricultural Education and a Master's degree in Curriculum and Instruction. She currently teaches at a small, rural junior/senior high school with an approximate enrollment of 220 students. Her course load consists of exclusively agricultural education classes.

Mike

Mike has been teaching for 25 years. He earned a Bachelor's degree in Agricultural Education and currently teaches at a medium, rural junior/senior high school with an approximate enrollment of 400 students and a two-teacher agricultural education program. His course load consists of exclusively agricultural education classes, and he has approximately 100 students in his program.

Nina

Nina has been teaching for 25 years. She earned a Bachelor's degree in Family and Consumer Sciences (FACS) and a Master's degree in Organizational Leadership, and has taught in three school districts during her career. Currently, she teaches at a middle and high school with approximate enrollments of 500 students respectively. Her course load consists of career and life planning courses, as well as a middle school FACS 9-week rotation course. She completed the metacognitive professional development, but was unable to complete curriculum implementation due to time constraints.

Tim

Tim has been teaching for 33 years. He earned a Bachelor's degree in Agricultural Education and later a Master's degree in Education. He currently teaches at a rural high school with an approximate enrollment of 135 students. His course load consists of exclusively agricultural education classes, and he has approximately 100 students in his program.

How Teachers' Perceive the Learning Process in a PBL Environment before an Increased Metacognitive Awareness

How teachers perceived and facilitated the learning process during a PBL environment draws upon data collected during the first round of interviews, and includes two main themes,

Beliefs on Teaching and PBL Benefits. Themes, Categories, and Codes are displayed in Table 4.2.

Table 4.2 *Themes, Categories, and Codes from First Round of Interviews*

Theme	Category	Code
Beliefs on Teaching	Student Thinking	Improving Students' Thinking
		Transition Students' Thinking
	Failure	Benefits of Failure
	Driving Engagement	Teachers Drive Engagement
	Responsible for Learning	Remediation
		Full Class
	Learning as Discovery	Enabling Student Discovery
		Should be Exciting
	Importance of Relevancy	Relevance to Students' Life
		Relevance to World
	What is Success	Participation as Success
		Process/Connections as Success
		Assessments as Success
		Eagerness to Learn as Success
PBL Benefits	How PBL Engages	Student Action
		Teacher Perspective
	Accountability	External Forces
		Internal Forces
	Storage	Not Rote Memorization
	Ability to Help Students	Group Learning
		Focusing on Personal Factors
		Outward Behavior

Theme One: Beliefs on Teaching

The theme, *Beliefs on Teaching*, explored how teacher-participants view their role in student learning. Teacher-participants discussed various aspects of the learning process as it pertains to their students, including the need for engagement, relevancy, and discovery. Their discussions often focused on the teacher as accountable for students' learning. While focusing on

the need for students to be able to fail, Tim also iterated the need for students to enjoy learning and he often characterized himself as the driver for engagement. Similarly, Nina expressed the value in facilitating engagement for students, while also discussing how she can help students when they struggle – oftentimes seemingly placing the 'burden' of student learning on herself. Many teacher-participants also explored relevancy, as Andrea discussed how she sees relevancy as one of the most important steps in the learning process for her students. These, and other ideas are further explored in the following categories: *student thinking*, *failure*, *driving engagement*, *responsible for learning*, *learning as discovery*, *importance of relevancy*, and *what is success*.

Student Thinking. The category, *student thinking*, contained two codes including *improving students' thinking* and *transition students' thinking*. At times, teacher-participants expressed their desire to improve students' thinking through various avenues. Cindy cited the desire to pose more questions to improve student thinking,

> So everything from word choice to tone, to your body language, and really, setting it up – you're, you're probably going to have to change that from student A to student B. And you can't have the same – like we typically do in front of the classroom – we typically have the same tone, we say the same exact thing. It might be a good idea if, or hey, you should check out this, I wonder if it might help you with da, da, da, da. So posing questions, not directly stating 'you should do this, don't do that.'

Similarly, Nina expressed students often only want to know "what's right," and further expressed her desire to improve student thinking:

> …how to think beyond a yes/no answer. As teacher, there's a segment of the population that has really, they don't want to, they don't want to go beyond that yes/no – 'I only want to know what's, what's right,' and so we need, that habit needs to be broken.

In a slightly different way, Andrea discussed helping her students' thinking with math problems, and afterwards they (students) "started understanding more questions to ask, rather than 'I just don't understand what's going on here.'" At times teacher-participants expressed a desire – while acknowledging a current insufficiency – to impact student thinking, as Gabby explains:

> And so whether that's either explaining the process or maybe giving hints and clues about, um, I don't know, best practices might be a way that you can help them out to have more overall success and in your classroom as well. I would say it's probably not something that I necessarily do.

In addition to the focus on improving student thinking, a few teacher-participants also expressed a need to transition students' thinking by holding students accountable for their thinking, albeit a skeptical belief in actually realizing that result. Cindy explains:

> My hopeful side of me says yes. But, um, [sigh] my realistic person inside of me says students are only going to be as good as you hold them accountable to [be]. And so I might get a completely different response from Billy than the English teacher or the chemistry teacher… But, if you are not holding them accountable to it I just don't think it's gonna happen for 90% - 95% of the students – I just don't think it's gonna happen.

Further, Mike suggested students will be accountable for their thinking if given a chance at ownership,

> …if they have the choice to prove their knowledge in the way that they prove it, I think they own it. So it goes, if you ask the question and they have freedom to choose the proof, I think they're gonna have, take more ownership in the, in the, in the response…

Failure. An element critical to the perspective of one participant, and highlighted by a second, is the focus of the next category, *failure*. Failure is comprised of one code, *benefits of failure*, and is mostly substantiated by Tim. When discussing PBL and how it impacts learning, Tim suggested it is important for us to "learn from our mistakes" and he feels "failure can be sometimes our best instructor." He continued to relate failure to the scientific method, stating, "not always do we prove our hypothesis," and "we need to make sure that a student understands that failure does not mean not-success. It is just one of the steps in the learning process." Elucidating his preference for PBL environments, he suggested PBL offers students an opportunity to fail without it crippling them academically:

> You know, when we're looking at PBL, we can fail something and we don't hold it against you, you know, we fail a test on a traditional class, it may have a tendency to structure the future of our career.

In a concurring description of failure, Nina highlights the need for students to see her struggle, too, "So they need to see me struggle at something, and ask for help, and get it figured out…Because if I'm standing up there and everything just flows perfectly, that's not helping them grow." While only two teacher-participants offered perceptions related to failure, this category represents a relevant discussion on how those two teacher-participants make meaning of the learning process.

Driving engagement. Akin to the previous category, the next category, *driving engagement*, is comprised of a singular code, *teachers drive engagement*. Interestingly, this code is comprised of quotes from four participants – the two exceptions, Cindy and Andrea, happen to be the earliest in their respective careers out of the six. This code represents how teachers perceive their need to drive engagement for students – somewhat related to the next category, *responsible for learning* – whether it be a focus on varying instructional methods, or simplifying projects in order for students to engage. Some teacher-participants described situations where their driving engagement was more subtle, as Nina says:

> And then you've got the extreme, the student that just wants to get it done, and the group is holding them back. And so that's, again, where the facilitator, the teacher, has to be aware of what's going on and help work through that dynamic. Or you have the student that just wants to sit back and not do anything. And so again, the facilitator has to be engaged, and know their students because to have a good team, all the pieces have to fit.

Later, she described a desire to engage multiple learning styles, "So you make sure for the kinesthetic learner and auditory learner, hands on, so on. So that you do appeal to those, those styles of learning."

Tim was more specific with his stated goal of engaging, saying he focuses his planning "on the engagement activities." He continued, discussing how he goes about planning, "How am I getting the students involved? What do I need to have as resources? How am I going to line this

up so that I can have multiple facets of different learning styles going on?" Mike offered evidence in alignment with Nina and Tim's focus, suggesting he keeps students "engaged and involved" through open-ended questions. Lastly, Gabby offered the most compelling statement, focusing on how she helps students struggling while in a PBL environment by working through the unit project and developing a more digestible timeline:

> Because it might be that they're struggling with the process maybe isn't lined out enough, and it's open-ended. And so that's where you kind of give them a check sheet of these are the items that need to be done in your project. So sometimes with project based learning, it might be more that they don't like the open-endedness that, you know, here's your big projects you have to do, and here's your steps. So kind of creating a timeline for them or a checkoff list just to help those students along with some of that process.

Responsible for Learning. The next category, *responsible for learning*, is parallel to the previous in that it highlights how teachers hold themselves accountable for student learning, and in turn, student thinking. They feel they need to digest information for students when students have trouble, or diagnose problems for students, instead of having students diagnose on their own and develop their own thinking. Responsible for learning includes two codes, *remediation* and *full class*.

When teacher-participants described situations involving remediation strategies, they frequently discussed adjusting things for students, as Cindy described "sometimes I need to adjust the content or the assignment to help them a little bit… more traditional assignment I might be, um, going, revisiting the topic and going back and trying to explain it in a different way." or figuring out what "we" need to do in order to move forward. Similarly, Mike's description of assessing students in a more traditional class setting highlighted an element of responsibility to recognize a student is struggling, "it may be toward the end of the grading term before we realized that they weren't getting the information." Andrea's description is in alignment also, discussing the need to identify holes in learning in order to fill gaps for students,

"And then go back and try to figure out where the holes of information are, so we can fill those in."

Likewise, teacher-participants also described taking responsibility for students when it came to other components of learning when remediating struggling students, such as homework, as Gabby says, "So typically you make sure that they have the notes, or that they have the homework." When working with struggling students, Andrea offered how she works to help them formulate better questions after finding out "what exactly they're struggling with," and she tries "to continue to guide them through." Andrea, and others, also tended to focus on how they can make connections for students, "And then try to find a way for it to relate to the real world to them." Gabby offered a similar statement about helping students,

> "And then…once they have that information, trying to break it down even more for them, you know, so maybe giving a word bank or giving them websites that have definitions to words, or ways that they can help."

The second code for responsible for learning was *full class* and focused on how teacher-participants perceived learning with whole-class instruction. Ideas related to this code commonly allude to participant's feeling responsible for the learning that does, or does not, happen within their classes. Gabby discussed how she feels she has to stay on track, and thusly uses a checklist; otherwise students will miss out:

> …then also keeping myself on track because I like to sometimes take tangents and if I don't keep myself on track, then we won't have enough time to get through everything that I want to get through in the school year.

She even highlights the need to "trick" students into learning, because otherwise students may be resistant,

> …trick students into the fact that they're learning. Because, if they, I don't know, I think sometimes if you let them know the process that you're doing, I don't know if they become resistant to it or whatever, but some of my, like type-A, students struggle a little bit…

Continuing the focus on holding responsibility for student learning, Cindy described securing resources for students during PBL, saying she might go "out and find two or three reliable pathways, or channels" for students, and she "want[s] to be specific on their information that they're finding and they're actually going to give me solid work." Andrea offered a response consistent with Cindy', discussing how she tries to anticipate student troubles,

> I focus on what my goals are for the students, um, to accomplish at end of that day. So, we go through and discuss that at the beginning of the class. And they know, kind of, how we're going to structure the class, and how long that they have to get each one of the tasks done. Um, and what questions that they could possibly pose to me. So I can make sure that I'm trying to anticipate the difficulties that they're going to have, to help that struggling students to make sure that they're getting knowledge that day too.

Mike discussed the need for students to investigate, but also talked about needing a format and structure for students,

> But there has to be a format to start with. I mean, then, they have to know the process. It doesn't take very long. But if you don't lay that foundation to start with, then you'll probably struggle, you and the student.

He continued further, describing a need to focus energy on developing a quality question that will drive students' learning throughout the PBL process,

> To ensure that the student has a direction of investigation that they can follow. And it takes a little bit of training to start with. To get students to do things that way because they're not used to it. But, the way the question is asked will drive the direction that the student takes in answering or providing data to prove that they know the answer to the question.

Lastly, he described looking for struggling students by examining their journals, "And if I have to go back and look through their journal, I can see about how much they're getting or not getting."

Learning as Discovery. The next category, *learning as discovery*, highlights how teacher-participants see discovery by students as a critical component of the learning process. It

is comprised of two codes, *enabling student discovery* and *should be exciting*, and is substantiated by notions from five participants. The first code, *enabling student discovery*, focuses on how teacher-participants attempt to foster the opportunities students have to discover while learning. Tim and Mike discussed the need for teachers to let students discover versus feeding them information. Tim suggested he does this by remaining mindful to not just direct students, "I would say that is given me the process that I have to watch myself – I want to tell the kids how to do things – and allow them to sometimes discover more." Likewise, when proposing the impact PBL has on students, Mike described students asking themselves questions instead of the instructor, "because they're asking themselves questions rather than the instructor asking questions."

Another angle of enabling student discovery taken by teacher-participants was highlighting how students think differently when discovering. While discussing a successful PBL student, Gabby offered, "What is it that we're doing? Or, you know, even, some of that goes a little bit to inquiry, like, they're asking upper level questions as well." She continued and offered an example of a different type of question students may ask during traditional instruction, like "students might ask some more engaging or, like, thought process questions of…why did they bring animals to America?"

The second code under learning as discovery is *should be exciting*, and focuses on how teacher-participants see learning as an endeavor that should be exciting. Tim was a catalyst for this thought, opining school should not be boring, "To me, school should be an adventure; it should be an interesting activity where we are wanting to come and learn more stuff, not being a drudgery." The idea of learning being fun was later revisited by Tim, as he further concluded "Well, I think the key too, is, one, as I mentioned previously, know that learning can be fun."

Tim's view of education being exciting was supported by Nina, who discussed the importance of teacher modeling,

> So, they're, you have to model your excitement for learning, your excitement to want to continue learning…. because if they see the teacher, they see the teacher excited and eager to learn, I really feel that has a ripple effect.

Importance of Relevancy. The second to last category under the theme beliefs on learning is *importance of relevancy*, and focuses on how teacher-participants view the need for learning to be relevant for students, both to students personally and to the world at large. Teacher-participants tended to focus on the urge to create learning experiences that are relevant for students, and often described PBL as an avenue for accomplishing that. In the first code, *relevance to students' life*, Tim suggested teachers need to show students that knowledge is worth their time, "And so we have to, as an instructor, have to open up the door and show them the light that makes things relevant and makes things worthy of their learning…" Similarly, Nina delves into how PBL provides relevancy,

> I think it gives them a real, real life experience and it provides relevancy in their learning. Um, instead of, you know, I'm not a Stand and Deliver, but if they can't make that connection to what is in their life, or see what it could be, then, um, they don't you know, they're not as eager to engage.

Andrea continued the focus on relevancy, suggesting PBL offers some student individualization "I think with [project]-based learning you can continue, like I said, to, to gear it towards their interest, and make it more individualized." Mike and Gabby round out the code with a focus on real life application, with Mike offering "real life application" as an impact on learning. Gabby suggested PBL "makes it relevant to real life" and continued to discuss how students need to know 'why': "So I think kids sometimes, especially nowadays more than ever, want to know, like, the reasons why, why are we learning this? Why are we doing this?"

The second half of importance of relevancy is *relevancy to world*, which focuses on teacher-participants' need to relate learning to the broader world for their students. Tim offered a representative statement about the importance of students learning through other disciplines, "it's actually more through the hands-on experiences and knowledge gain, we can correlate it through multi disciplines, which I think is very important…" Andrea continued with this line of thinking, as she suggested students solving a PBL problem "have to look at the world and how that problem fits into it, and how they can actually solve a real world problem." She postulated relevancy makes "it real for them [students], they actually want to learn it", instead of just learning "what I want them to learn." Gabby offered what is the last quote for the relevancy to world code, focusing on the future of students "And so I think with PBL it makes it more relevant to what they're going to be doing in the future…we're…preparing them for careers."

What is success. The final category of the beliefs on teaching theme is *what is success*, and is characterized by how teacher-participants view success for their students. What is success is comprised of four codes, including *participation as success*, *process/connections as success*, *assessment as success*, and *eagerness to learn as success*. The first code, *participation as success*, is substantiated by four teacher-participants and focuses on viewing student participation as success. While discussing how he assesses students, Tim asked "Are they participating?" and suggested "So participation plays a key role." Correspondingly, when discussing success in traditional education settings, Cindy wants students to "interact with myself and other students," and wants "them to be asking questions." Gabby continued the focus on participation, offering a successful student in a PBL environment is "actively participating."

The second code in the what is success category is *process/connections as success*, and includes contributions from four teacher-participants. Nina offered a thought on how connections are important for teachers, too, and not just students:

> And then when they take that information and they can apply it to their class, it's super cool. And I love that when teachers share that with one another. So they [teachers] not only know what you were doing in your classroom, but how they brought that information and applied it in their classroom. That's huge, really huge. So, you know, looking for those connections is great.

Continuing with the focus on connections, Cindy suggested success is when students make connections on their own to how the learning relates to their world:

> …they are asking more to me that is a little more in-depth than they have thought about it …they are beyond just vocab and they're actually starting to think about how it relates to their world and things they have seen. So we might talk about weather, we might talk about how the weather affects the crops, and somebody might share their experience…

Lastly, Tim offered a statement that aligns with Cindy', as he postulated students are successful when they understand how things build upon each other, "But if we can understand common sense, and processes, and the knowledge of how things build upon one another, we are successful."

Assessment as success is the third code from the *what is success* category, and includes a focus on how teacher-participants, at times, may view assessment-related items as success. The views displayed in this code are often in reference to teaching in a traditional setting, as Cindy suggested she wants students to "do well on the assessments that I give [in traditional classes]". Tim concurred when discussing success in a traditionally taught class, "And in a traditional class, we're going to base it on…percentages, and test scores…" Mike's take followed suit, focusing on – among notetaking and asking questions – test scores as determining success, "scored above average on the quiz or test at the end."

The final code from the *what is success* category is focused on *eagerness to learn as success*. Teacher-participants' references to an eagerness to learn ranged from just wanting to be there, to an elevated level of excitement. Cindy' idea on eagerness starts us out, as she highlighted how she just wants students who want to be there, "I want them to actually care about the topics that they are working on because you know they sign up to be in that class, and I want them to actually want to be there." Further down the continuum toward more excitement and eagerness to learn, Mike posited a student is successful when they "want to know what the question of the day is when they first walk in the room."

Taking the next step and entering the realm of excitement, and not just a slight eagerness, is Nina's idea of a successful student being one that is eager to share their learning with others:

> I think the successful student is the one that's just excited and eager to tell you what they're learning, what just happened. "Come over and see this Mrs. Nina." You know, that's, and sharing it, not only sharing with me, but also sharing it with some of their other teachers.

Andrea further stated her idea of success is a student coming to class ready to learn, but is also still excited regardless of the educational environment:

> They're engaged. They come to class ready to learn. Often I don't have to get them started. They'll come to class with questions, and they start the ball rolling themselves… generally they're excited to come to class too [in traditional settings] because they understand what's going on.

Theme Two: PBL Benefits

The theme, *PBL Benefits*, explored how teacher-participants view PBL instruction and traditional instruction. Teacher-participants discussed several aspects of PBL instruction, including how it engages students, fosters accountability both though internal and external forces, promotes learning other than just rote memorization, and offers the opportunity to help struggling students. When discussing how PBL engages students, both Cindy and Nina

mentioned PBL incites students to dig deeper, while Andrea alluded to PBL holding students accountable for their own learning. Many teacher-participants also explored how PBL is more than just rote memorization, with Gabby iterating traditional styles of teaching oftentimes rely on rote memorization learning. These ideas, and more, are further explored in the following categories: *How PBL engages*, *accountability*, *storage*, and *ability to help students*.

How PBL engages. The first category in the theme PBL benefits is *how PBL engages*, and is focused on the perception teacher-participants had that PBL helps engage students. The category is comprised of two codes, *student action* and *teacher perspective*. The first code, *student action*, is focused on the actions PBL is purported to invoke among students, mainly being the perceived increase in student thinking about content. Nina offered a statement that seems to summarize the code, as she suggested PBL creates risk takers who dive deeper, "they'll be a risk taker. They'll dig a little bit deeper." Likewise, Cindy and Andrea contributed to the same sentiment, when Cindy postulated, "taking it one step further or a little bit deeper than they normally would have in, like, that traditional setting," and Andrea suggested, "And the difference between the problem-based learning is, you know, they're continually diving into it."

While not in perfect alignment with Nina, Andrea, and Cindy, Gabby's thoughts also emphasized student doing. She discussed PBL classrooms being more doing-oriented, "it's more that they are, like, learning by doing and they're doing the activities." Later, she focused on successful PBL students being "engaged" and "actively working" on the task at-hand. Lastly, she described a student who is engrossed, "they might not be specifically writing everything down, but they're engrossed in whatever it is that you're discussing or talking about or you're working on."

The second code, *teacher perspective*, is focused on how teacher-participants view PBL as an engaging tool. For Tim and Gabby, PBL offers a way for students to see where the learning is headed, or the path they will take, as Tim said,

> …[PBL] allows them to be directly involved by allowing them to have some ideas about starting and closing, by giving them the opportunity to witness the project developing as it goes along, and to give them a lot of buy in on to how the project is going to work.

Gabby offered a similar thought, focusing on how PBL offers students steps in their learning,

> …I think that Project-based Learning does a good job of like, here's the eventual outcome that we'll get to, and so here are kind of the steps that we learn, and so it gives them a scenario of where we're going, and then this is kind of the steps that we're taking to get there.

However, Tim also postulated other ways PBL engages students, highlighting how PBL can help a teacher make use of different learning styles:

> …you use different ways of working with that project. And so you're trying to make sure that you're hitting all the opportunities for all learners to be successful through a large gambit of different teaching styles, which that Project-based brings about.

Continuing this sentiment, Nina discussed how PBL has changed her role to more of a "facilitator," and that PBL can cause students to explore more content, as they "springboard off in different directions." Completing the shift in focus from how PBL offers a path of learning to how PBL further engages students, Andrea suggested PBL "sparks their [students'] curiosity."

Accountability. The second category, *accountability*, highlights how teacher-participants see PBL as a way to increase student accountability. It includes two foci that developed into separate codes, *external forces* and *internal forces*. The first way teacher-participants noted PBL develops student accountability was through *external forces*, or forms of extrinsic motivation. For instance, Mike discussed how the questions teachers pose to students during PBL impact how the student is held accountable, and that simple answers let students "off the hook" so to

speak. He further discussed the importance of asking good questions as a basis for holding students accountable,

> "They need to know that… they can't just answer yes or no. It has to be, you know, when they're working on the answer, they're not, they're going to think, 'well he's not going to accept that simple of an answer. He wants to know that we know this. How are we going to prove it?'

Other teacher-participants expressed beliefs about PBL helping students be accountable through external forces at various levels of specificity, as Cindy stated broadly, "holds them [students] accountable for their learning more so than what I'm gonna say the traditional classroom does." She went further and said, "it pushes them to think on their own," and offered that PBL peer evaluations help keep students accountable, "that kind of helps hold some of those students accountable for their grade when maybe they didn't carry their weight in the group." Nina postulated a similar feeling, saying group presentations – during PBL – hold all group members (students) accountable because "everyone has to speak." Finally, Andrea tries to reinforce that added accountability by having students do outside work, too, "work on the outside so their partners don't have to take care of all of it."

The second way teachers saw PBL as helping student accountability was through *internal forces* – meaning both the context of intrinsic motivation, as well as intra-group motivation. Mike offered a slant towards PBL as being as "close as you can get to coaching intrinsic behavior," also suggesting "It makes them [students] want to learn..." Cindy suggested her own take in alignment with Mike's, as she stated in reference to PBL:

> I've seen students, you give them a topic and you kind of put them in the driver's seat of choosing, um, or some extent of how far they want to go into what they are learning, um, and kind of be more at their level, or they can push themselves as they want to. Which is what your ultimate goal is, is you want them to push themselves…

Cindy's stance is supported in a statement Tim made about his own aspirations for students in his PBL course being for them "to have a desire to take it to the next step, to maybe do things on their own." Continuing the focus, Nina offered PBL makes students "owners of their learning," which is part of that "responsibility."

Diverging slightly from the intrinsically focused element of accountability, Andrea and Cindy offered a position relating PBL and intragroup motivation, as Andrea discussed how she coaches her students about mentoring each other during PBL,

> It, it helps you as a learner learn if you can teach someone else, or if you can help them through those struggles too. So I really try to have them help each other, but I model that for them first, so they understand what that looks like.

Veering slightly away from her other sentiments, Cindy suggested an additional stance in alignment with Andrea's focus on intra-group motivation,

> And when they are working on the projects usually there is a group leader, and they are telling the group what needs to be done, and are kind of in charge, versus the teacher being in charge and kind of telling them 'hey you guys need to get on this still, and you need to complete this still.'

Storage. *Storage* is the name of the third category, and is comprised of one code focused on how PBL is more than rote memorization. Frequently, teacher-participants noted how traditional instruction was focused on rote memorization, while PBL engaged students in deeper thinking. Tim offered a representative statement when discussing traditional instruction, "And the student would basically memorize stuff, and usually it would be stored in a short-term process for regurgitation on a, on a test." He also made reference to traditional instruction being a "spoon-feeding" approach. Andrea's beliefs affirm Tim's, suggesting PBL challenges students more than traditional instruction, as PBL is more challenging "than the regular rote memory that we typically ask them [students] to do." She even suggested students still struggle to break the regurgitation cycle from their traditional instruction days, "they're still struggling with the 'I

want to learn stuff and then regurgitate it.'" When examining how PBL has impacted her, Gabby offered how she *used* to do things, "I used to probably do like, you know, here's rote memorization of some different facts, or like here's a PowerPoint and we're going to learn about it and then test on the end of it."

When shifting their focus to PBL, teacher-participants usually described how PBL caused students to think deeper about the subject matter, or helped put learning into long-term memory, as Tim discussed here, "And I think with that opportunity to put things into that long-term memory basis it gives us a lot more, that learning process that's going to be more beneficial instead of a regurgitation…" Mike's suggestion is in alignment, with a focus on retention, "retention is higher I think. Rather than strictly notes or lecture, or even traditional labs, it's a little more meaningful."

Ability to Help Students. The final category in the benefits of PBL theme is focused on how teacher-participants viewed PBL as helpful in working with students, both in identifying struggling students and in helping students. The category is comprised of three codes: *group learning*, *focusing on personal factors*, and *outward behavior*.

Many teacher-participants noted how PBL offers more chances for group learning, and how group learning can benefit students. Cindy highlighted how working in groups affords the opportunity for her to sit down with students and troubleshoot a problem, "So we discuss like why isn't that being done, well, are we having a problem finding the information … So then, typically its 'we have to re-word our search phrase…'" Likewise, Gabby suggested students during PBL groups engage with themselves, as well as the teacher, "students are actively, like, working with each other, and actively working with the teacher as well, too." She continued to add that groups promote collaborative "success."

The latter portion of the group learning code focused on how PBL groups can involve students in the learning process with their peers, and is driven by thoughts from Nina and Gabby. Nina discussed how PBL groups could enable students to take risks while learning, as she said,

> Well, the students, they just love working with one another…If they're not a big risk-taker, then working with a group it's a little bit, my observation, it's a little bit easier for those risk-takers to go ahead and share an idea.

Nina's belief was supported by a statement made by Gabby, who referenced students working collaboratively even when they are not required to, "Typically, I think also they're working in groups, so even if it's an individual product, you'll see them, like, discussing with one another about their projects." Finally, Gabby described engagement with students during PBL as being focused on asking themselves questions, "And I think all kids are either asking those questions, or discussing when they're in, in their group, like, an answer to the questions."

The second code under the *ability to help students* category is focused on how PBL enables teachers to *focus on personal factors* when working with students. Nina was a driver for this idea, discussing how relevant student "baggage" is in the learning process, and how important good group pairings are in PBL. She also discussed building trust with students, "you can build up that trust, then you can get to 'is learning going to take place?' and 'how can I engage this kid?'" In addition, she talked about how students can have empathy for someone when they are struggling with a concept, "that they can communicate with one another, and communicate their ideas to someone else. Also, that they can have that empathy for, one of their co-students who may not be grasping things as quickly, and help them learn." Cindy also highlighted the importance of focusing on students' personal factors, suggesting students will have trouble learning if their personal/emotional needs are not met,

> …I kind of know when they walk in – from that moment they walk in if they are having a great day, an okay day, or a crappy day. And to me, if they walk in and they are having a really crappy day, they are not going to learn anything anyway.

The final code, *outward behavior*, encompasses teacher-participants' tendency to report looking at student outward behavior as an indicator for success. Gabby put a point on it when she suggested PBL is "back to more observation, versus, necessarily, a grade." She followed with how she is "observing the student and seeing if they're struggling with the concept" while in PBL. In a suggestion that further defines Gabby's point, Nina highlighted how she observes students, "Body language is huge. And I guess that's really what I'm looking for, more so than the product that they turn in." Further, she described "sinking in their seat" and whether students are "collaborating with other students" as identifiers she looks for.

Andrea and Mike both highlighted experiences similar to Gabby and Nina, as Mike described looking at student behavior related to writing, "They have to provide data and I just walk by and if they're not capturing information or making an attempt to provide data in response to the questions." Equally, Andrea described identifying a struggling student as one who "quits" and decides "'I'm going to sit here and watch my partner do it.'"

How Teachers' Make Meaning of, and attempt to facilitate, Metacognition in a PBL Environment after a Metacognitive Professional Development

How teachers made meaning and attempted to facilitate metacognition during a PBL environment draws upon data collected during the second and third rounds of interviews, and includes five main themes: *Metacognitive beliefs*, *teachers' conceptualizations*, *teachers' partial conceptualizations*, *facilitating metacognition*, and *teacher expectations*. Themes, categories, and codes are displayed in Table 4.3:

Table 4.3 *Themes, Categories, and Codes from Second and Third Rounds of Interviews*

Theme	Category	Code
Metacognitive Beliefs	Teacher attitudes toward metacognition	Enables more learning
		Helps become better learner
		Helps inform teachers why students succeed
		Broader realizations of learning
	How teachers view metacognition and students	Done by 'good students'
		All students can
		Students can (but won't)
		Student aversion to metacognition
		Student ability (can't)
		Building resiliency
	Teacher self-efficacy	Confidence in self
		Feelings of inadequacy
		Feelings of inauthenticity
		Metacognition as easy
Teachers' Conceptualizations	Perceiving metacognitive knowledge	
	Perceiving metacognitive regulation	
Teachers' Partial Conceptualizations	Metacognition and cognition	Cognitive understanding
		Higher order learning
		Making broader connections
		Making connections to content
	Metacognition and teaching	Helping others learn
		Better teacher
		Student choice and ownership
	Metacognition as doing	Limited to certain times
		Doing assignment
		Engagement
		Reflection
		Self-starter
		Self-efficacy as key to metacognition
		Organized
Facilitating Metacognition	Higher expectations	
	Asking more questions	Learning output questions

		Processing questions
	Include metacognitive strategies more	Timing of metacognition
		How to include metacognition
		Metacognition and discretion
		Lead by example
Teacher Expectations	For students	Success
		Student laziness
		Student doing metacognition
	For teachers	Teacher as responsible
		Attempt to be clear

Theme One: Metacognitive Beliefs

The theme, *Metacognitive Beliefs*, centered on how teacher-participants feel about metacognition and student learning. Teacher-participant discussions revealed an emphasis on the importance of metacognition in student learning. Highlighting how metacognition enables students to learn more, or become more proficient learners, was a common element of teacher-participant interviews. However, feelings about metacognition started to diverge as teacher-participants discussed metacognition and students. Some thought all students are capable of metacognitive thinking while others considered metacognitive ability reserved for already higher-achieving students. That divergence continued when teacher-participants expressed their confidence in working with students and metacognition, with some being overly confident and others more hesitant. These and other ideas are further explored in the following categories: *Teacher attitudes toward metacognition*, *how teachers view metacognition and students*, and *teacher self-efficacy*.

Teacher attitudes toward metacognition. The category, *teacher attitudes toward metacognition*, contained four codes including *enables more learning*, *helps become better learner*, *helps inform teachers why students succeed*, and *broader realizations of learning.*

Metacognition enabling students to learn more content was a view espoused by five of the six teacher-participants. Cindy, when referring to how a perceived metacognitive knowledge deficit impacted a student's learning, suggested it's "huge because they're missing out on so many chunks of content." Similarly, Mike discussed how a lack of metacognition can cause students to achieve at a lower standard, "I think that the kid that doesn't have those, doesn't implement or try to think about how they learn best is always going to be either slower or reach that mastery level at a lower standard." Taking on a slightly different view, Gabby and Nina expressed how metacognition could impact students' necessary time to master a concept, thus allowing the teacher to cover more topics. As Nina said, a student that struggles with metacognitive regulation is "going to take…longer to get to that depth of understanding;" while Gabby suggested a metacognitive learner will learn something correctly the first time, thus allowing the teacher to "get through more because they're (students) fully aware of what they're doing."

Helping students become better learners was also a focus of teacher-participants when discussing metacognition. One angle described by teacher-participants was the notion that metacognitive ability makes students better learners in all contexts, not just their own classroom. Cindy offered that metacognition impacts students by making them "better students in other people's classrooms," so even if a student has a bad teacher, the student can still "get something out of that opportunity." Mike's discussion was in agreement, proposing some students already have it (metacognition) figured out, "which made them a little bit more of a successful student." Gabby postulated similar feelings about student success in several areas outside of her own classroom:

> And the reason we're doing that is to help make sure that you're successful, not only in this class, but you can take those same skills and then you can use them throughout all of your classes, or projects that you're doing at home.

From here, the discussions shifted toward how metacognition makes students better learners, with Gabby highlighting metacognition helps students with problem solving, "and I think that metacognition helps you as far as being a learner and a problem solver…. when something harder comes along, what new skill could I use?" Likewise, Andrea posited students that know more about themselves are more successful because those students know how to apply new knowledge, "because the more you know about yourself, the better you are at learning new knowledge and how that applies to you." Additionally, two teacher-participants referenced how students completing the PBL curriculum projects (after their respective teachers had undergone the metacognition facilitation workshop) during the study had better products and grades than ever before. Tim offered his student's grades were higher "than they've ever been," and Andrea suggested the projects completed were "probably…better than classes I've had in the past. And I think part of that was just I was focused on the learning process rather than the result."

In the third code for the category *teacher attitudes toward Metacognition*, teacher-participants highlighted how metacognition can inform teachers on why students are successful. Cindy offered a reflective idea about metacognition that challenged the existing paradigm for many teachers and how they see student learning:

> It's something that impacts the way your students learn on a – I don't want to say deeper level – but on a whole another level that you may or may not have been aware of when you went through the teaching block at whatever school you went to.

Andrea offered a thought in agreement with Cindy, when she suggested she had not previously considered that an element of metacognitive knowledge in particular could be the downfall of students, "I didn't even take into consideration that maybe students had strategies that they were, they just didn't know where to apply them." In a slight divergence, Mike suggested that while his views of what a successful student is had not changed, he now understood why they were

successful, “I don't know that it changed my view of what the successful student looks like, I think it changed my attitude about, or my understanding about, why certain students are more successful than others.”

Finally, Gabby and Nina both offered more independent thoughts, as Gabby postulated she had altered her view of what success is, “I think the way it changes my views is helping the students to achieve success for themselves, like, what they, so they feel more successful in their own learning process.” Instead of altering her views of success, Nina initially hoped metacognition would allow her to gauge struggling students better, “those students that you have concerns about, it may be a faster gauge for me as to if they're getting the concept or not.”

Similar to the previous thoughts, teacher-participants also described metacognition as influencing broader learning realizations. Andrea discussed how her views on why students struggle with concepts changed because of metacognitive awareness:

> I guess I've always looked at that as kids that I've had to help more versus kids who I felt were sharper in a subject, but I learned as I've looked through and reflect back, especially on metacognitive thinking, that those are kids who have learned how to learn versus kids who are still struggling with those principles.

She continued and later highlighted how she has adjusted working with students who struggle,

> but also the other part of me being able to look at students in a different lens and in a different light of it's not that they can't organize their information, they just might not know how to yet. And being able to then help those kids with organization of information rather than just giving them more and more information.

Similarly, Nina offered how her views of student struggle have been changed by metacognitive awareness, as she discussed a student knowing why/how they struggle at reading as being more important than just focusing on being good enough to get by, “But that's not going to, um, that’s not going to be as beneficial as trying to figure out why you're struggling with the reading. Is it vocabulary, is it comprehension?” Mike offered a point that serves as an exclamation mark when

he likened a teacher who does not use all relevant knowledge of the learning process (i.e., metacognition) to malpractice, "if a teacher is teaching students and not impacting their brain, which is the organ where the knowledge is going into, and have an understanding about the student learning, that's malpractice."

How teachers view metacognition and students. The category, *how teachers view metacognition and students* is comprised of six codes, including *done by 'good students,' all students can*, *students can (but won't)*, *student aversion to metacognition*, *student ability (can't)*, and *building resiliency*. A recurrence among all teacher-participants was a propensity to discuss who does metacognition. Which type of student? Both Gabby and Cindy posited metacognition was done by 'good students,' with Gabby suggesting higher-achieving students are ones most likely to exhibit metacognitive ability:

> And they know that, you know, after high school that they're going to probably technical school, or straight into a job or military. And the reason I think that they would struggle with it is, because, I think, schools as a whole are set up for other, for students who are who are good at school to succeed.

She continued, and highlighted once more how more successful students are more likely to use metacognition, "So a student who's successful with metacognitive knowledge, what do they look like? I would say that's going to be your 'A'/'B' kids, ones that are craving to want to do better." Cindy offered ideas in alignment with Gabby, as she suggested middle and higher-tier students were more reflective, "I would say the middle, the middle tier and the higher tier were a lot better about their reflective states." In a separate discussion, she postulated gifted students are the ones who choose what works best for them, while other students do not, "And I feel like some do that already [choosing what works best for them in learning], you know, those really gifted students already do that. But there are a bunch that don't."

Contradictory to previous ideas about higher-tier students and metacognition, Gabby also provided the thoughts explored by the second code, suggesting all students have an ability to use metacognitive strategies. While discussing how oftentimes educators focus on the 'middle' tier of students, she suggested the two 'end' tiers are the ones metacognition can benefit the most, "I think your two ends are the ones that can really benefit from this a lot." Continuing, she offered for some students (i.e., not higher-achieving) it is a "matter of exposure," but improvement can be made. Andrea described a similar thought, when she postulated all students can learn, "I think everybody has the ability to learn. I think metacognition is something that is a skill that's developed."

Every teacher-participant with the exception of Nina put forth the idea of students having the ability to do something, but choosing not to. Cindy, Mike, and Gabby offered thoughts that suggested students could do something but they simply choose not to. While referencing a student lacking drive to utilize metacognitive knowledge they already possess, Mike suggested "they're just not learning as much as they should or could." Likewise, Cindy discussed students with attention span difficulties and metacognitive regulation struggling as "they know what they are supposed to be doing but they just have a hard time staying on task." Gabby then described a more forgetful student, "And I think the kids that struggle with that are the ones that probably have good intentions and want to do it, and they'll, they'll make the plan, but then they forget to do the other steps." Diverging from the others, Tim and Andrea both postulated scenarios where students' choices are more nuanced. While discussing student differences in metacognition, Tim suggested student success with metacognition depends on the student's drive to be knowledgeable, "Oh, yeah, I mean, I think a lot of it depends on the, the individuals assertiveness, I think a lot of it dependent on their character, I think a lot of it on their enthusiasm

to be knowledgeable, too." Andrea, on the other hand, described a situation where students will get out of doing for themselves unless a teacher forces them, "And I think their monitoring and evaluation of themselves is going to be difficult in the beginning because that's another thing that they expect a teacher to do for them. Not necessarily for them to do for themselves."

Andrea was the sole contributor to the thought students had an aversion to metacognition. This aversion was described as a fear of it, almost balking at chances to practice it. When discussing how students will say 'I don't get it,' or not try at first, she posited, "Because they would prefer, they prefer not to do work that they don't feel that they need to do, but they also don't like to fail." She continued to discuss that initial aversion as where most difficulties with metacognition lie, as it is "going to start with 'I don't know what you want me to do, I've never seen this before. I'm just completely confused by the entire process.'" Lastly, while examining metacognitive knowledge struggle with students, Andrea highlighted again the fear of failure by students and how it creates aversion, "I think it frustrates them, they often think that I'm asking too much out of them. Rather than trying…and that comes, I think, back to their not wanting to fail, and their fear of failing."

Represented in the code *student ability (can't)* is another idea posited by teacher-participants, the possibility some students cannot do metacognition – whether it is based on their previous academic ability or their age. Cindy and Mike offered the idea student ability could prohibit metacognitive strategy use, as Cindy cited a student who she views as struggling mightily, "one of my students is so low it doesn't matter what you do she just really struggles to understand a lot of things." Likewise, in a discussion before he implemented newly learned metacognitive facilitation techniques Mike hypothesized a much larger group struggling with metacognition:

> I can just imagine in the class that I'll be dealing with that about half of them will have already, if I ask them why they did something the way they did it, they'll have a quick response. Logical response. And the other half won't even understand, first of all, what I was even asking them to do, let alone realizing that they'd ever tried to think of that on their own before.

Going in a different direction, Gabby and Andrea contributed to the age rationale, as Andrea suggested that maybe some of her older students would be better able to identify their own struggles:

> And I think that's, I think that's with the age of the kids that I'm teaching that, it comes, it's harder for them to have those really reliable questions of "I'm struggling with this skill," or "I'm struggling with this question."

Gabby offered a very similar thought, positing her younger students struggled with the regulation part of metacognition,

> because I think that they would be utilizing a little bit more, because my first group of eighth graders were a little lower achieving kids. And so I don't know that many of them got to the regulation step of it.

The final element of the *how teachers view metacognition and students* category is the idea of metacognition as helping to build resilient learners. Some teacher-participants' thoughts centered on how metacognitive learners have higher self-esteem, as Nina suggested students successful with metacognitive knowledge will "definitely" have higher self-esteem. Tim took it one-step further, citing not only increased self-esteem but also a thought of students being ready to take on anything:

> Well, if you're successful in both directions, one, you have a positive self-esteem. Two, that means you probably feel that you are able to tackle about any opportunity that's thrown at you because you have learned how to learn and you learn what your strengths and weaknesses are.

Gabby continued with the notion of confidence, offering a regulative learner is one who understands how to get things done, "So, to me as you get to that regulation piece, and you're understanding it and you're using it, like you're just building a confident learner, and problem

solver who understands, like, this is how you get stuff done." While contributing to the overall idea of increased confidence, Andrea slightly diverged and posited that increased confidence is because metacognitive learners don't just focus on extrinsic rewards, like grades, "With them, I don't know, thinking more about how they think rather than the grade it helps them continue to work at, at projects even though they find them difficult." Later, she added students that are successful with metacognitive knowledge are "not afraid of failing."

Teacher self-efficacy. Teacher-participants frequently referenced their beliefs in their own ability to facilitate metacognition with students, and those espoused beliefs comprise the next category, *teacher self-efficacy*. Thoughts from this category are reflected in four codes, *confidence in self*, *feelings of inadequacy*, *feelings of inauthenticity*, and *metacognition as easy*. Most teacher-participants alluded to a form of self-confidence during discussions, but the exact nature of that confidence was different for each participant. Cindy suggested she felt "better" after having done the in-person PD, and that she had a working understanding of metacognition, "I feel like I have a foundational/working knowledge of it." Mike offered a thought that suggested he has confidence in his ability to foster metacognition; he just needs to tweak it so that it has more student buy-in initially, "but I think if you spend more time at the beginning, developing, setting the stage for it [more]." Somewhat similar to Mike, Gabby postulated the biggest sticking point for her was if she would remember to explicitly incorporate metacognitive strategies and discuss it with students, "I don't think I'm confused by anything. For me, I think, my biggest worry is if I'm going to be intentional enough with the kids to point it out." Andrea and Tim both professed more confident tones, with Andrea describing her comfort as "I still feel pretty comfortable with it," after she had implemented the curriculum. Tim was the most

confident of the group, predicting, “it’ll be fine” before he implemented the curriculum, and then positing it “is fine” after implementing the curriculum.

However, not all teacher-participants felt confident in metacognition the whole time during the study. Their lack of confidence centered on several aspects, one of which was a feeling of inadequacy, which is the focus of the second code, *feelings of inadequacy*. Mike’s feelings comprise most of this idea, as he felt uneasy with metacognition even after the PD events, “It was just very unclear to me, not because you didn't explain it, but because it's new to me and I can't, it was hard to get my brain around why isn't it.” He also suggested he was “gray” on some elements of metacognition after the training. Nina’s thoughts were comparable to Mike’s, as she described leaving the PD having “learned a lot,” but still “thinking I really needed to learn more.” Those feelings of needing to learn more carried through, as she later discussed in her third interview “struggling to feel comfortable” with metacognition (it should be noted Nina was unable to complete the curriculum implementation). While Mike and Nina’s feelings were consistent through the second and third interviews, Gabby offered a different perspective. In her own words, she left the PD event feeling confident, but found it was more difficult to facilitate metacognition than she initially anticipated:

> And I wanted it, I felt like it would be more ingrained in me by that second part. And so, um, I was a little disappointed kind of in myself that it didn't come quite as easily as I felt like it was going to this summer.

Mirroring Mike and Nina’s feelings of inadequacy were feelings of inauthenticity, the focus of the third code. Nina described feeling nervous about being able to make metacognitive facilitation “flow,” and wondered if she could “be natural when…talking to students.” Mike also discussed feelings of inauthenticity, but his thoughts were much more centered on how the pre-developed curriculum caused him to struggle, “I was struggling with trying to teach the canned

lesson." He continued by adding it "did not feel natural." Noteworthy, in one instance Mike also likened metacognition to the use of "strategies," when discussing how he was stretching "between what [I am] teaching them and convincing them to use this strategy."

The final element of the *teacher self-efficacy* category focused on a couple teacher-participants' beliefs that metacognition was easy. While referencing other PD she participated in focused on Growth Mindset, Gabby posited metacognition is something done by some without even knowing it, "metacognition is something that your good students and probably teachers already do and set up without really realizing it." In a similar vein, Tim mentioned most of the time his students "kind of know a little bit about what works and what doesn't work for them," and "really never noticed one of [his students struggling] with it."

Theme Two: Teachers' Conceptualizations

Teacher-participants' observations about metacognitive knowledge and regulation that align with conceptualizations found in research were explored in the theme *teachers' conceptualizations*. Teacher-participants discussed both positive and negative outcomes of metacognition when offering their observations (e.g., one quote may mention a student struggling with metacognitive knowledge, while another may include a student successful at metacognitive knowledge). Substantiating the theme are thoughts from all six teacher-participants, which comprise two categories, *perceiving metacognitive knowledge* and *perceiving metacognitive regulation*.

Perceiving metacognitive knowledge. The category, *perceiving metacognitive knowledge*, centered on teacher-participants conceptualizations of student use of metacognitive knowledge. Oftentimes, these conceptualizations concentrated on students struggling with metacognitive knowledge – and how that struggle may manifest in the classroom. Cindy

suggested a strong argument for how metacognitive knowledge struggle could impact a student, as she described a student running but not actually going anywhere,

> I feel like they're just lost all the time. And to me, uh, it would be like in their brain things are going, like, 50 bazillion miles per hour, because they're panicking, because the anxiety is high, because they don't know what they are really supposed to be doing. They don't know what outcome, they have like the far outcome, that they are supposed to be reaching but they don't know which path to take to get there and it's like a jumbled mess.

Building on Cindy' thoughts, Gabby considered how that panic and anxiety may manifest for a student, with them ultimately becoming frustrated – either because the teacher thinks they are lazy, or because they want to do good but are struggling:

> I think it hinders them because they get frustrated, and, um, frustration can look, I think, a couple ways in kids: one, it can look like that defiant kid that, they're frustrated because they haven't been able to learn, and then the teacher thinks it's because they're lazy or they're not doing their work, and so then it kind of becomes more defiance. Or I think a high anxiety kid is another one, and where, um, they want to do good, but they're struggling and they don't know why they're struggling.

Tim added a discussion on strengths and weaknesses, and how a student struggling with metacognitive knowledge would not be able to identify their own weaknesses:

> Well, I think, one, if they're not very good at it it means that they're not finding their strength, or, or being even knowledgeable of their weaknesses. And so, they will, if, they will, you know, even if they're a desirable learner, they could be studying or learning or participating in ways that may not benefit themselves.

Andrea and Nina offered summarizing representative ideas focused on students struggling with thinking and understanding, as early on Andrea posited most of her students would not even "know how they think." Equally, Nina suggested students would not be able to tell her what they don't understand, "inability to tell you where they're struggling or what they, they don't understand."

In juxtaposition to focusing on negative outcomes, teacher-participants' conceptualizations of metacognitive knowledge also highlighted positive outcomes, such as

students utilizing metacognitive knowledge. When discussing how metacognition can impact learning in the PBL process, Andrea highlighted expecting students to be able to identify missing information, "I see it as them being able to think through problems and figure out where they're missing information, and go back and collect that information." Mike also articulated how metacognitive knowledge could help learners, as he described students identifying the best ways they learn, and then applying that knowledge to new situations, "Once a student identifies…how they learn best, then they can go back and, on any new information, can develop strategies to help themselves. Regardless if it's a lab or lecture, prepping for a quiz or test." Likewise, he pondered how he recognized students using metacognitive knowledge elements, suggesting he asked "them how they prepared for" an assessment, looking for conditional metacognitive knowledge focused on whether students chose preparation steps that enabled them to best meet their study needs.

Perceiving metacognitive regulation. The second category, *perceiving metacognitive regulation*, aligned with how teacher-participants conceptualized metacognitive regulation. A seldom focused-on aspect of metacognitive regulation was planning activities undertaken by students, with Gabby offering a rare focus on it when she referenced a successful regulating student as one that writes "out the steps" before a big assignment is due. However, despite the lack of focus on planning elements of metacognitive regulation, several ideas put forth by teacher-participants were centered on students being able to monitor their thinking in the moment, as Cindy suggested a student struggling with metacognitive regulation would not be able to express "their [own] line of thinking" on how they arrived at a conclusion. Similarly, Gabby described a student monitoring his or her own understanding while reading a text by

"thinking about the way [they] are reading it." Likewise, she postulated what the next step of a monitoring student would look like,

> [when a student encounters a problem] they will kind of think back, like, 'okay, what else is it that I can do?' 'Or what else is it that I can use to be able to solve this problem?' And look at it in a different way.

Andrea suggested that next step may be the student realizing they need to ask questions, "So in regulation, it's just they understand that they're not getting the material and they're, they're asking questions."

Focusing on how students evaluated themselves was also a key part of the discussion on metacognitive regulation. While describing how she wanted to facilitate metacognition, Cindy offered that maybe students should be required to evaluate for themselves instead of her doing it for them, "more questions focused on their thought process, and less on the actual task. So, trying to get them to analyze and evaluate where they're at instead of me trying to do it for them." Mike suggested that maybe it is on the teacher when trying to facilitate metacognitive regulation and student self-evaluation, "[as teachers we tend to] go on [to the evaluation/assessment] rather than to stop and think how can I make this kid learn on his own better? It's a different mindset on the teacher's part as well." Continuing the focus on student self-evaluation, Andrea posited that is what becoming a lifelong learner is, "really what becoming a lifelong learner looks like, is understanding why you put stuff in and why you took stuff out, and why you failed at that and why you got better." Finally, Nina referenced what happens when a student has difficulty self-evaluating, citing they "don't understand what they aren't understanding."

Theme Three: Teachers' Partial Conceptualizations

Teacher-participants' tendency to confound metacognition with other elements of the learning process comprised the theme, *teachers' partial conceptualizations*. Confounding ideas included cognitive understanding, teaching, and student actions. First, I explore how teacher-participants equate thinking about thinking (i.e., metacognition) with cognitive understanding and rigor (e.g., higher order thinking). Next, how metacognition and teaching intersect is explored. Lastly, I examine how teacher-participants view metacognitive action by students.

Metacognition and cognition. The first category, *metacognition and cognition*, centered on teacher-participants' proclivity to intertwine elements of metacognition and cognitive learning, and includes four codes. Cindy, Gabby, and Tim all offered ideas that correlated metacognition with cognitive comprehension, with Gabby describing a student who struggles with metacognitive knowledge as one that "didn't know how to do something" and subsequently just shut down. Very similarly, Cindy' discussion of a metacognitive knowledge-proficient student hints at a focus on cognitive understanding, as she described a student that asks deeper questions about subject matter, "they will ask questions right after that group presents, that dive a little bit deeper, which tells me then they are processing the information they presented well." While Tim also tended to focus on cognitive understanding elements, he was more focused on how students would learn for the long term (i.e., would their comprehension permit them to remember the information years later). Naming it "realistic learning," Tim highlighted long-term memory when asked about how metacognition fits into PBL, "And that means long-term memory, that means the opportunity to put things into a better understanding." He added to this idea later when discussing the impact of successful metacognitive regulation, as he described not

just being regurgitative, “not become regurgitative, but become long-term knowledge, you know, actually be educated, not just who's got the best short term memory.”

In the same vein as confounding metacognition with cognitive understanding, is teacher-participants’ tendency to confuse metacognition with higher order thinking, or learning rigor. This is the focus of the second code, *as higher order learning.* Gabby offered an emblematic thought when she discussed a student that struggles with metacognitive knowledge. Gabby’s surface-level insight on the situation is correct, but her focus is subtly shifted toward the student’s experience of only being required to do lower-order learning tasks:

> I have one really, really smart one that struggles with it a little bit I think, because they want you to tell them exactly what it is that they're supposed to do. And I think that they struggle not in the fact that they don't have the ability, but they're just so used to someone being like here are the 8 vocab words that you have to learn and you write down the definition, and then you memorize them.

Nina highlighted a similar situation with students when she discussed an example of a successful metacognitive knowledge-using student as one that does not just repeat basic facts:

> Well, I think about when, for example, let's say we watch a video, and I want the students to tell me how they're going to apply what they watched on that video to their, their lives. I don't want a regurgitation of the video. I want an application of the, the message in the video. So the student that is excelling is, you know, going to be able to take that very far. Whereas the other student is going to be more of a repeat of the video.

While still focusing mostly on higher order thinking, Tim and Andrea both included discussion that were slightly divergent from Gabby and Nina. When contrasting metacognition and deeper thinking, Tim postulated metacognition gives students the “opportunity to develop into” deeper thinkers. Andrea continued the look at deeper thinking when she posited students struggling with metacognitive knowledge aren’t digging deeper, “And they're not trying to find any other answers, they're just trying to get the project done, and they don’t do any deeper digging than the base line answer of the question you've asked.” Later, Tim shifted to focus on

not memorizing, and described a student that is utilizing metacognitive knowledge as having the opportunity to "level the playing field" with other students, because they aren't "dealing with simply who can memorize the best."

Another idea teacher-participants discussed was metacognition as an avenue for helping students make broader connections with content and the real world. Tim served as the major contributor to this idea, as he tended to focus on the practical or relevant parts of learning when discussing metacognition, "I like the opportunity to constantly get the kids thinking in a practical sense, in a reality sense." When describing a student struggling with metacognition, he suggested maybe they aren't seeing the relevancy of the task, "They're possibly not…fostering the relevancy of the project." He also offered an emblematic response when discussing what metacognitive knowledge success looks like:

> And that, you know, like the other day they saw where corn was being recalled, and cauliflower was being recalled, and red lettuce was being recalled. And so it got them to be more aware of the real life goings on and got them to read what was causing it and being much more aware of everything.

Mike, Andrea, and Nina all offered like comments when describing metacognitive knowledge success among students. When commenting on how metacognitive knowledge-proficient students ask questions, Mike instead veered toward how they came up with relevancy for the topic, "it wasn't so much questions they would ask but it was comments related that would come out…and they would, on their own basically, come up with the relevancy of what the topic was." Similarly, Nina discussed a metacognitive knowledge-successful student as one who can take information "further than what is being presented" and "build on it," while Andrea described metacognitive success and its impact as wanting "to question the world" and "find out more information all of the time."

The final thought evidenced by teacher-participants in the *metacognition and cognition* category was that of equating metacognition with content connections within a unit of instruction. While Gabby was a big contributor to this idea, Andrea offered a representative response when she discussed the times during a unit of instruction in which students are the most metacognitive:

> But if I have an assignment that's just a day or an experiment, they don't seem to have a lot of metacognition in it, because they think that's just a, that's just something to do that day. But in the project, it's, it's connected and they have a lot more reflective thoughts in it.

Gabby offered a response that reinforces Andrea's viewpoint, when she referenced metacognitive knowledge use as making connections,

> And like, there was no connection whatsoever. So for them every day was an individual lesson. And the kids I could tell that were using it were like, oh, this is how, like, what we did yesterday relates to this today.

Likewise, Cindy and Tim both referenced connections when discussing metacognitive regulation, with Cindy partially equating metacognitive regulation to students "connecting all the dots." Tim offered that students struggling with metacognitive regulation need help identifying how topics build on one another, "you just need to work with them and try to get them to, to see how things are building, you know, once again, interlock aspect of it and everything and try to get them to process it."

Metacognition and teaching. The second category in the *teachers' partial conceptualizations* theme revolved around how teacher-participants interpreted the intersection of metacognitive thinking and teaching. Much of this centers on the idea of conceptualizing metacognition as an avenue for helping others learn, or bettering teacher-participants' own instruction. The first of three thought narratives is metacognition conceptualized as being students helping other students learn. Cindy offered an emblematic discussion by referencing

metacognitive knowledge utilization as putting content into delivery mode, “It should be when they are working towards creating their, their projects. And, like, thinking about how they're going to put their content into delivery mode.” She later followed up with an example of a student proficient in metacognitive knowledge as one who thinks about others’ learning styles when preparing a presentation,

> and I thought that was a great way of her, like, thinking, okay, how can I incorporate these things that I've learned and in a visual way for students to see something so simple, that is basically things that we've already done, but it wasn't all of those things in one.

Cindy later returned to that story when describing metacognitive regulation utilization by a student, “Um, more like, I think, like, Eza where she's thinking not only about how she learned it, but how she wants her classmates to learn it.” Moving the focus toward action by the student, Gabby suggested a metacognitively regulating student is one that helps others, “they're also helping prompt other kids and move them along towards that success as well.”

Another penchant of teacher-participants was to liken metacognition with becoming a better teacher. Instead of focusing on how their new knowledge of metacognition could be translated to facilitating student use of it, teacher-participants referred to metacognition as an avenue to better their instruction. Tim highlighted this well when he discussed how metacognition fits into the learning process:

> Oh, I think it's, you know, I think it's throughout. Not only is it something that we need to think about as a way of getting kids to learn, but I think it also allows us to think about how to prepare the items and get [students] ready for it; and to use it as a way of arranging our lessons and to providing [students] with learning activities and all that type of stuff to get them to think about it in multi facets.

Gabby offered a similar sentiment when discussing how metacognition impacts mastery, honing in on ultimately how she can help students learn:

> I also think it's important that if you have to reteach it, it's okay, because then as a teacher, you're reflecting back maybe a little bit of like, what your strategy was or what didn't work and how can I help the students learn better.

Lastly, Mike referenced giving students learning inventories so he could better understand how they learn when he was describing students struggling with metacognitive knowledge, "that would help me understand how they would learn best."

The final idea in the category *metacognition and teaching* examines how teacher-participants' saw metacognition as increasing student ownership of learning. A representative statement was offered by Andrea, as she postulated metacognition impacts mastery of learning by increasing learners' responsibility:

> They pick and choose to interact with the knowledge in a different way to help them continue to gather more knowledge than what they would have possibly done before… And they have the responsibility of learning, and it's not just because it's today in food science, it's because it's a lifetime and you're going to be a continuous learner.

Equally, Cindy suggested the benefit of metacognitive knowledge was students were now discovering for themselves, "Because, you're not spoon-feeding them information and you're not spoon-feeding them their whole learning experience, they're out there doing the discovery and the trial and error components." Although in agreement, early on Nina suggested ownership needed to happen, "I think it goes back to ownership on the student's end of learning. I feel like many students are too dependent on the teacher, and they need to learn the skill of learning for themselves." Meanwhile, Mike was in agreement that metacognition made students think for themselves, as he suggested metacognition is "the correct way to teach students to teach themselves."

Metacognition as doing. The final category in the *teachers' partial conceptualizations* theme explored how teacher-participants conceptualized student doing of metacognition. The *metacognition as doing* category is comprised of seven different codes. The first highlighted how

teacher-participants view metacognition as only happening at certain times during instruction. When asked about where metacognition fits into the PBL learning process, Cindy offered a characteristic response that limited metacognition to one particular point in time during the unit of instruction:

> Well ideally it's supposed to be when they're working on their team task log and they're supposed to be thinking about how they're creating their project, or their outcome of their scenario, and thinking about the best strategies and the ways that they would like to learn.

Although others' assumptions of where/when metacognition mostly happens were different, every teacher-participant suggested metacognition may be mostly limited to a specific time. For Gabby, those were two separate times. She postulated metacognitive knowledge happens toward the beginning of an instructional PBL project, "So I would say that's kind of more towards the beginning. Like when you are introducing concepts to them, I think is when they're more, like, gaining that knowledge." However, it was at the end of a unit when students are creating their presentations that she suggested metacognitive regulation happens,

> at the end when you're putting the big project together is the one where you kind of were like, here's the big project, you know…to me, that's where they're using…some of those skills, or you're helping them point out those skills…so here's the actual project, use this knowledge to be able to put the presentation together. To me, that's when they're the most metacognitive, because they're having to rely on those prior, like, the prior things that they've learned.

Congruently, Tim posited the end stage of a PBL unit is when students are most metacognitive, as they are pulling everything together:

> I think, to me, course toward the end. Because we're starting to put everything together. And it's becoming a much more relative activity to where 'aha' starts to kick in, and, and it's, you know, the process of hands-on doing, being conscientious of what we're doing, that type of thing… And so, as we're building on it, I think we have a crescendo toward the end of everything, you know, it's just like everything, we peek toward bringing all our past knowledge and experiences come together, and it starts to, see the light bulb starting to really stay on then.

Andrea offered a very similar thought to that of Tim and Gabby, suggesting most metacognition comes in "the presentation stage" when students are making connections back to previously learned concepts. Somewhat similarly, Mike also described students using metacognition toward the end of a unit. However, instead of it being when creating a presentation, he postulated it was when students chose how they would "prove" their knowledge, citing metacognitive knowledge success was when "they select an appropriate response or way of proof that they know the information." Maybe the most divergent was Nina, who early on (i.e., in the second interview, following the metacognitive PD) anticipated metacognition would be more of a "summary" or "wrap-up."

Less frequent than limiting metacognition to particular times, two teacher-participants also limited metacognition to the act of completing, or doing, assignments. While subtle, at times teacher-participants offered thoughts that highlighted metacognition could be as simple as a student doing an assignment. Mike offered a discussion that serves as a good example when he referenced a metacognitively regulating student as occurring when he did not just automatically provide all of the information students needed, "The monitoring, the, basically that just amounted to me not giving them all the information they needed, and causing them to have to move forward on their own." Later, he went on to describe a metacognitive knowledge-successful student as one that has figured out the assignment and is ready to move on, "Probably one would be, have already figured out and want to know what's next. What's the, what's the next thing I can prove that I am good at?" Cindy also indicated doing the assignment was akin to successful metacognitive knowledge implementation:

> Like you give them all the content and the end game, and maybe it's online, or maybe it's in person, whatever it may be, and they are going through the content on their own and then figuring out how they are going to process it. And whatever shape or format – maybe you don't give them an actual format, but, they come up with their own format.

Engagement was also an idea referenced by four of the teacher-participants when discussing various elements of metacognition. Mostly, engagement was identified as a way for teacher-participants to diagnose metacognitive struggle with students. Gabby provided an emblematic thought while discussing how she identified students struggling with metacognition, "the usual cues as far as not answering or not participating when we're having a discussion would probably be the first clue that a student is maybe not getting it." Parallel to Gabby, Tim suggested a student struggling with metacognition would not be cohesive, "well I think there's several ways of identifying. One, a student is not as cohesive, they're frustrated, they're not as actively engaged." Andrea also posited a lack of participation in group work would suggest a student struggling with metacognition, "In group work, if they're not participating at all, that's usually a pretty good indication that they aren't understanding and don't know where they should be going." Engagement was also referenced as a way to identify success with metacognition, as Gabby offered a story about a student that exhibited metacognitive knowledge successfully:

> So at the beginning of [the] PBL unit, she kind of sat back and didn't say anything, and then it was kind of cool to see at the end of it she was the one leading the group and understanding it.

Also focusing on success, Nina suggested a metacognitively regulating student was one that was "very engaging."

Teacher-participants also had a propensity to reduce metacognition to simple reflection, driven either by the teacher or the student themselves. Nina offered the most characteristic idea for teacher-driven reflection as metacognition when she posited metacognition is asking students to reflect, "I see metacognition as a way to improve and enhance those [critical thinking and problem solving skills] because as we're asking [students] to reflect, we're asking them to take a step back, and what would you do differently?" Similarly, Andrea discussed facilitating student

reflection as a way to promote metacognitive regulation, “Whenever we do reflections, I usually have them go back through and we answer the questions out loud….And that gives them a chance to realize that maybe their knowledge was incorrect.” Albeit hinting at accurately conceptualized elements of metacognition, Gabby also described posing reflection questions to students to promote metacognition:

> So that to me, is where you do some reflection questions, you know, if you've just done a reading strategy…it's like ‘well, why did you remember that?’ ‘How [did] you remember it?’ So I think it's directed questions to the students so that they're reflecting on that process.

Although similar in that they rendered metacognition down to the act of reflecting, at times teacher-participants also described student-driven reflection. Cindy offered students are most metacognitive when they have received their grades, “probably after they got their reports, their grades back….they actually start thinking about what they learned and how they could have done better.” Gabby also presented a student-driven reflection occurrence, citing a student exhibiting metacognitive regulation would be “able to see ‘Do I need to make changes to that?’ And, you know, ‘what changes do I need to make?’ and then reflecting on whether or not that process was good or not.”

An idea not alluded to often, but mentioned by five of the six teacher-participants, was that of metacognition as being a self-starter. While being a self-starter was mostly used to describe students that were metacognitive, Andrea used the void of self-starting as evidence a student was struggling with metacognitive knowledge:

> They just don't know how to get started. I guess is, you know that, even though they may have the assignment set out in front of them, you know, they're usually twiddling their thumbs and they just don't know where to go from there.

Flipping to the positive side, when discussing what a metacognitively regulating student looks like, Gabby suggested it was one that automatically started working without asking questions:

> So you could tell the kids that would listen and take on that role, that they just automatically started moving through it. Like, there was no permission asked on how to use a program or how to complete an activity.

Tim offered a comparable thought when discussing success with metacognitive knowledge, positing it would be a student who doesn't require prompting and is thinking about things in advance:

> One that does not require prompting in the sense that they are already leading the thoughts on how things…[are] affecting us in our modern day life…instead of being prompted and being given a lot of inside clues and all that type of stuff, they have a tendency to be already ahead of the game and thinking about these things prior to.

Cindy and Nina both offered shorter descriptions of a metacognitive student, with Cindy suggesting a metacognitive knowledge-successful student works "independent," and Nina positing metacognitively regulating students would likely be "taking the lead."

Several teacher-participants also referenced self-efficacy when discussing metacognition, as the next code examines self-efficacy as the key to metacognition. Gabby referred to self-efficacy when discussing the impact of a student struggling with metacognitive regulation, as she described the struggle as becoming a barrier, "it becomes a barrier that 'I can't do something.'" Citing a similar need for efficacy, Tim suggested a student struggling with metacognitive regulation is one that doesn't participate because they felt they were unsuccessful previously,

> They don't grasp the activities. They don't strive to answer the questions. They don't participate near as well because they, when they have done so they don't feel that they were successful, and thusly then they are lacking their desire to participate, or be involved.

Lastly, Andrea posited her own thoughts on the concept of efficacy when she posited a metacognitively regulating student was one that had self-confidence and excitement, "I think it's definitely, once again, just talking to the students when they're giving their presentation, that kind of self-confidence and the excitement that they have in what they're talking about."

The final idea for the *metacognition as doing* category focused on metacognition as organization, with two teacher-participants contributing. Gabby and Tim both referenced organization as a key for success with metacognitive regulation. Gabby suggested a struggling regulatory student is one that is "probably unorganized in general." Tim's discussion supported this notion, as he suggested successful metacognitive regulation was more likely to be a "much more organized individual."

Theme Four: Facilitating Metacognition

How teacher-participants attempted to promote metacognition within their students' thinking is the focus of the fourth theme, *facilitating metacognition*. Ideas for facilitation included notions like expecting more from students and their thinking, asking more questions about how students processed information, and incorporating more explicit instruction of metacognitive strategies. The following three categories are explored: *higher expectations*, *asking more questions*, and *include metacognitive strategies more*.

The first category, *higher expectations*, centered on teacher-participants' propensity to cite having higher expectations of students' thinking and regulating abilities as a necessary element of promoting metacognition. Andrea offered a characteristic response when she discussed providing students with metacognitive strategies, but then holding them accountable to direct their own thinking:

> Just giving students strategies to help them…think about their thinking. Um, to give them the knowledge so they are learning to apply and regulate themselves and their thinking process. Rather than just having the teacher be in charge of it all and them feeling like they don't have responsibility.

While offering a similar stance on holding students accountable, Mike focused more on evaluation in particular and described requiring students to make their own judgements on products, and revising if necessary, "And then I would just put it back on them to prove to me

that it is or isn't [correct], which then forced them to revise if it wasn't." Later, he went on to suggest he will allow more time for "monitoring and revision" in future instruction. Lastly, in a similar kind Cindy discussed holding students accountable to being able to explain their thinking, and that if they "can't tell [her]" because it looks like they followed someone else's plan, then maybe the student needs to restart.

Asking more questions. The next category, *asking more questions*, aligned with teacher-participants' inclinations to ask questions to promote metacognition. The first idea pertains to questions focused on learning outputs, and was substantiated by Cindy and Andrea. Cindy referenced questioning students about outputs when she discussed how she would help a student struggling with metacognition, as she highlighted an opportunity to walk them through using a task log:

> I would have them fill that (task log) out and I would have them do it in even more detail. Um, okay, so what does this task even actually look like? Walk me through those steps, how you are going to get there.

Similarly, Andrea described focusing on steps to arrive at a desired output when working with a metacognitively struggling student:

> And helping them start to rephrase their questions, instead of 'I just don't get it' to what part don't you get? And what are some, let's talk through if you use this strategy, what's it gonna look like to your end goal? If you use this strategy, what's it going to look like to your end goal?

Somewhat similar to output-focused questions, teacher-participants also described using processing questions to help facilitate metacognitive thinking. Whole group questioning during instruction was how Mike anticipated utilizing this type of question early on, as he described asking questions to "get them to think about how they could learn it better, or what worked for them kind of deal." Gabby discussed having used a similar type of questioning, focusing on getting students to analyze why they were or were not successful with a specific task, "asking

those questions of, like, well why do you think this worked for you? Or what is it that, you know, you did or didn't do, you know, that made you successful?" Andrea suggested the same type and style of questions as Gabby, positing it is more of a conversation focused on what a learner did and why they did it,

> It's the conversations that you have with them, or the questions that you ask them to talk about why they did things the way that they did them. Um, what strategy did they use there, and why did they choose to use that strategy?

Include metacognitive strategies more. The final category within the *facilitating metacognition* theme is comprised of how and when teacher-participants incorporated more metacognition into their instruction. The first notion was offered by Mike, Gabby, and Andrea, and focused on the timing of metacognitive instruction. Mike suggested the idea of doing less, better, when he postulated where metacognition can be incorporated:

> I think it's just being aware of the points in your instruction where it can be incorporated, or to be pointed out. It's, it's almost like we need to do less better, rather than being so focused on what getting from point A to point B.

Gabby offered a concurring suggestion, when she postulated learners need time and scaffolding as they build their metacognitive muscles, "And giving them a little bit more time and helping them scaffold that a little more, so they feel successful in the class, even though they haven't quite got to that point." Further, Mike went on to suggest students should be exposed to metacognitive instruction in all of their classes in order to reinforce it,

> That way it's not just my class or her class. When a student moves from period to period seven times a day, they're getting it everywhere. And I think that reinforced their, uh, I think it would just cause them to have to utilize it more and think about it.

Likewise, Gabby discussed the benefit of explicit metacognitive instruction, even though at first noting the need for it before a learning episode, before ultimately landing on needing it before, during, and after:

> I definitely think that one, especially at the beginning with the metacognition, is that you need to identify it, or help students identify that piece, maybe either before, like, before you're reading something so that they're kind of aware that this is going on, or before you're teaching, or right after the fact. So that way they can process it. So, um, I would say it's towards the beginning of the learning process, but then it also has to be facilitated kind of in the middle of the learning process, so that they realize that they're doing it.

Another topic discussed by Mike, Gabby, and Andrea was how each planned to incorporate metacognition strategies. In a discourse where he arguably missed the main point of metacognition (i.e., students thinking for themselves about their own thinking), Mike highlighted his perceived benefit that his students had been through a learning styles inventory, and that they had some ideas of how they could learn best already,

> it was a benefit that the students have been through a learning style inventory, and were aware of the learning styles that they have. And then the, the procedural and monitoring type things that they could actually, it listed it out for them, they didn't even have to think about ways they could do it, it just said here's some ways that you could.

Diverging slightly, Gabby suggested the importance of a teacher being intentional in helping students develop metacognition:

> Um, what I've learned about metacognition is that to get students to recognize that the skills that they need to be successful in the learning process, as a teacher we have to be much more intentional in what we're doing and saying to help them through that process.

However, she admitted that as the year wore on she fell out of the habit of explicitly discussing metacognition with students:

> And then as the school year went on, and it got busy, I don't know that I feel the same confidence because I felt like I was falling back into my usual patterns of not pointing it out to the kids, unless I made a conscious like, I would consciously have to do it.

Charting her own path, Andrea opined the importance of keeping a dialogue with students in order to diagnose how they are struggling, “Think keeping an open dialogue with them always helps. Because if they're not voicing out loud, it's hard to tell where exactly they are actually struggling with it.” She further discussed the importance of practice, “But it's, it's making sure

that I'm very intentional in the time and practice, and giving them the time, that time, to practice, because if I don't do that, I don't think that they will be successful."

Interestingly, Gabby put forth the notion that metacognitive instruction needs discretion, which is the focus of the third code. In a representative statement, Gabby postulated students don't want to admit when they are not understanding,

> I think that this could be where like a, either a journal activity, or, you know, say what you feel on a post-it note and do it anonymously, can help because sometimes students don't want to admit that they're not understanding, and that might be able to help the teacher.

Gabby offered a concurring thought, suggesting she would try to avoid putting students in an uncomfortable situation, "That's where I would definitely do the one on one with the student without trying to embarrass them or, you know, push them in an uncomfortable situation."

In the final idea for the *include metacognitive strategies more* category, Andrea and Nina suggested the need to lead by example. Discussing how she made her thinking visible while working a math problem with her students, Andrea posited it helped students see her thinking process, "And talking those things out loud, they finally were starting to get some of that….they're starting to see my thinking pattern of how I compute math which helped a lot of them out." Nina offered a concurring statement, adding that in PBL it is also important for students to model their thinking for peers, "I think that's very important for us to model it and I think in a [PBL] environment it's important for the student also to be able to model that within their group."

Theme Five: Teacher Expectations

In the theme, *teacher expectations*, I explored the expectations teacher-participants had for themselves and their students. It included a look at student apathy as viewed by teacher-

participants, as well as how teachers view effort as a prime driver for metacognition. In addition, the following categories are explored: *for students* and *for teachers*.

For students. The category *for students* centered on expectations teacher-participants had for students. The first idea postulated by teacher-participants dealt with success. Cindy posited success in her classes traditionally revolved around "assessment and grading," however she sometimes views success differently, "sometimes it is not about that student and whatever grade they get, but because they got this idea or they finally worked well with this other person." Mike offered a similar statement, highlighting how he sometimes has not had high expectations of success for his students when it comes to creative thinking, "I'll tell you right now in the, historically, they use what I end up telling them to use because they won't think for themselves. Because I never asked them to think for themselves basically." Diverging, Gabby suggested success can look "many different ways," while Tim posited grades oversimplify success and failure, and "mastery of the learning" is what he considers success.

The second topic evident in teacher-participants' discussions focused on the idea of student laziness – suggesting students can do it (i.e., metacognition); it's just a matter of if they want to. Cindy characterized it as a lack of effort into thinking about learning on her students' part:

> I think it's extremely important for students to understand [metacognition] because then, how they learn and making those choices to learn, in the way that works for them is really important. Instead of just focusing on learning, like, they know they need to learn, but they don't put a lot of thought, some of them don't put a lot of thought into what that might look like.

At times, she suggested that lack of student effort can be due to student home life and variables beyond the student's (or teacher's) control, "there are some students that you can try 10 different things, 10 different techniques, and it's still not going to do any good just because, because of

their home life." When describing a student who struggles with metacognitive regulation, Cindy opined that unless they have mastered winging it after not putting in much effort, the product will be okay at best, "Unless they have really, really mastered winging it, I don't know. Um, because if there is really no thought going into what they need to know."

Mike discussed a similar situation when describing what a student may look like that is struggling with metacognitive knowledge:

> It's probably a couple things in there, it's either, um, I don't want to say laziness, but just not willing to utilize the procedures that they already knew, you know they know what they are, they just choose not to use them.

Continuing, when discoursing metacognitive regulation struggle, Mike again painted a picture of a student with little effort, rather than a lack of mental ability, "Yeah, just not taking the time, or if during the monitoring process they would find the shortest route. And if revision was required, they may or may not revise, just because they met their minimal standard." Finally, and albeit much less frequently, Andrea suggested effort was an issue when describing what a student looks like that is struggling with metacognitive regulation,

> Those are the ones that are asking me in the middle of presentation, you know, what's my grade looking like, or they're not doing anything, and they're the ones that I have to sit by and prod and make sure that they're helping out their classmates whenever they're doing group projects.

Another element that came out of teacher-participants' discourse was what metacognitively active students looked like. Cindy was the main source for this idea, and posited a successful student with metacognitive regulation was one that asked questions, "asking questions – which could be different than asking for help." Continuing, she suggested those questions could be focused on figuring out the correct path to go. Additionally, she suggested a focus on evaluation, citing a student that was "trying to actually score herself on the rubric before she present[ed]." Mike and Gabby both offered very diverging ideas, with Mike

suggesting a metacognitively regulating student as one wanting "to feel like they're the smartest" in the room, while Gabby described a student who "stepped up and became more of a leader."

For teachers. The second category, *for teachers*, was based on the notion teacher-participants held themselves ultimately responsible for student learning. In essence, most believe if it's going to happen in my classroom, I have to make it happen. Cindy offered an emblematic perspective of this topic, when she described not "shoving [metacognition] down their throats enough,"

> But I think some are unintentionally doing it, and some are just not doing it at all. I don't know whose fault, probably mine, it's my classroom so I'll take ownership of that. Um, and not, like, shoving it down their throat enough I guess.

She also described holding herself responsible for helping students reflect at the end of lessons:

> Well, it would be really great if all students could reflect on their learning every single day. And sometimes they have that with the closing question. Other times they don't. So maybe on my end that would be being more direct, or changing up the closing question or having an additional question, so there'd be two questions, as I think having that reflection component would be a lot better.

Lastly, she suggested holding herself accountable for determining a struggling student's gaps in knowledge, "So it's really hard for me to gauge where she's at and what she has learned or what she's thinking about, what she needs to learn." Likewise, Mike opined teachers could help struggling students by "first learning how the student learns." Finishing his focus on teacher responsibility, he suggested he could have altered his delivery of the PBL curriculum to force students into monitoring and revising, "forced them into situations where they had to pay better attention to monitoring themselves and revising."

While diverging from Cindy and Mike's thoughts on teacher responsibility, Gabby, too, offered her own take on how she would take on responsibility for students' struggles, "[I would] pull the student aside and see, like, how can I differentiate, differentiate instruction for them, or

break it down a little bit different for them than what I could." Lastly, Tim articulated a similar situation to Gabby, suggesting working to identify how a student might be struggling and then offering changes, "identify that student that may not be grasping on....'have you tried this?' 'Have you tried that?' Try to help them figure out why they're not being as responsive to what we're doing."

The final idea in the *for teachers* category centered on Cindy and Gabby's self-imposed need to be clear, with Cindy offering she tries to put very clear steps on the board for assignments, "I try and post the assignment very clearly with steps on the slides – and then giving them the rubrics, that really helps." Likewise, Gabby suggested she was not properly setting up metacognition within PBL and put the onus on herself to make corrections,

> I'm not necessarily setting the students up for success with the way that I'm languaging it and setting it up. So if I am more aware of what it is that I need to do, like, I do a better job of setting up…and then connecting all of those steps.

Chapter 5 - Discussion

Introduction

This qualitative study sought to investigate how educators facilitate learning and perceive metacognition in a project-based learning (PBL) instructional environment before and after participating in professional development (PD) on metacognitive strategies. Teacher-participants were selected based on previous experience with PBL, specifically the *Food and Nutritional Sciences* (FNS) curriculum. Nine teacher-participants were selected to participate, with six completing three rounds of interviews following the Seidman Technique. The three interviews were aligned with the Guskey Model of Teacher Change (Guskey, 2002), and focused on how teacher-participants made meaning of metacognition and the learning process.

Data were analyzed following the constant comparative method (Glaser, 1965), with results presented in chapter four. Based on the natural break in the data (i.e., the metacognitive PD), interview round one was coded and presented separately from interview rounds two and three. Analysis of round one data resulted in eleven categories, which were grouped into two themes; while analysis from interview rounds two and three resulted in fourteen categories, which were grouped into five themes. After researcher analysis yielded themes, relevant themes for each research question were determined. Themes relevant to research question one, "How does knowledge of metacognitive strategies influence teacher perception of the learning process in a PBL instructional environment" included *beliefs on teaching*, *PBL benefits*, *metacognitive feelings*, and *teacher expectations*. For research question two, "How do teachers facilitate student learning in a PBL instructional environment before and after metacognitive professional development," three themes were determined to be relevant, *beliefs on teaching*, *PBL benefits*, and *facilitating metacognition.* Next, research question three, "What are educators'

interpretations of student metacognitive regulation and knowledge during a PBL instructional environment," had two informing themes, including *teachers' conceptualizations* and *teachers' partial conceptualizations*. Lastly, three themes, *beliefs on teaching*, *metacognitive feelings*, and *teacher expectations*, were identified as aligning with research question four, "How do teachers view their roles in influencing student metacognition." This chapter will present a short narrative of each teacher-participants' experiences in undergoing metacognitive PD, key findings for each research question, and a discussion of conclusions and implications for practitioners and teacher-educators and recommendations for future research.

Individual Participant Experiences in Metacognition

Andrea

Andrea is an early mid-career teacher, who is respected and knowledgeable at her craft. Arguably, she made the most connections conceptually with metacognition, expressing confidence after undergoing the PD. Further supporting this notion, she indicated a high self-perceived use of metacognitive strategies after completing the PD events. While her confidence maintained, she described her students' confidence with metacognitive strategies as being more fickle, "as far as my students, I don't know, they were sophomores, so I, there's a part of it that I think they're still growing and still developing." She frequently made the connection of metacognition with coaching, describing needing to demonstrate her thinking for students and then coach them through struggles when they encountered them:

> I think you can go back and, if students are saying 'I'm just not getting it, I'm just not understanding,' you can have them show you their work and you can do a more effective job of coaching them of 'well this is possibly why you're not understanding it.'

However, similar to Tim she made connections of metacognition with reflecting, in that she felt students were more metacognitive at the end of a unit when they can see how everything connects,

> the presentation stage…in this curriculum…there's a bunch of experiments that are going on, and for some reason my students …just look at that as a daily assignment….And then when they're doing their projects they connect those as if it is, you know, a full week of a project, so that is connected together.

Additionally, she found value in metacognition because it helped her see student learning differently, "being able to look at students in a different lens and in a different light of it's not that they can't organize their information, they just might not know how to yet." She postulated it also helped her think about students differently, "it helps you individualize your students and teach to individuals rather than just teach the content." She also commented the projects her students submitted were better than in years past.

Cindy

Like Andrea, Cindy is an accomplished, respected educator that is entering the early phases of being 'mid-career,' and at times this may have impacted her feelings towards teaching and learning and her students. She has been teaching long enough to have confidence in her abilities, but is pliable enough to adapt her paradigm of teaching and learning for new ideas learned during PD events, as evidenced when she described how students go about learning, "they know they need to learn, but they don't put a lot of thought – some of them don't put a lot of thought into what that might look like." She was willing to think critically about what metacognition might look like, as she postulated metacognition is "something that impacts the way your students learn on … a whole another level that you may or may not have been aware of when you went through the teaching block at whatever school you went to."

While she was engaged and willing to try metacognition facilitation, there were two potential inhibitors to fully conceptualizing, and operationalizing, metacognition: familiarity with PBL and perceptions of student commitment. Firstly, albeit a positive in other ways, Cindy was very familiar with the FNS PBL curriculum. She completed multiple FNS workshops, and was a lead teacher for the 2016 FNS Institute. Her curriculum fidelity score – the highest in the study – provides further evidence of this. She values PBL and its benefits, as she discussed it, "holds them accountable for their learning more." Additionally, because of her value for PBL, and her familiarity with the FNS curricular units, she may have confounded elements of metacognition with those of PBL, as she highlighted metacognition contributes more "ownership" of learning by students during PBL. Secondly, her discussions seemed to indicate she was in a phase of her career where she questioned students' commitment to education. Commonly, she referenced students having an ability to do more than they were willing, as she described a student struggling with metacognitive regulation as one that would "just go up and wing it [presentation]." This feeling toward student (lack of) commitment may have confounded her conceptualization of metacognition as the study progressed; focusing more on the effort aspects rather than the ability students may or may not have to think metacognitively.

Cindy's participation in the metacognitive PD events, as well as her second interview, indicated she was conceptualizing metacognition well early on. However, other data sources like the student writing prompts were incomplete and unavailable to provide further insight (see table 5.1 at the end of this section for full student writing prompt scores for each teacher-participant). Overall, for the two writing prompts Cindy had her students complete, students described utilizing more elements of metacognitive regulatory strategies than they described employing metacognitive knowledge elements. But, mirroring the trend toward a confounding

conceptualization of metacognition, metacognitive scoring for student writings decreased over the period of the second PBL unit.

Gabby

Gabby never quite seemed comfortable enough with metacognition to go "all-in." This is in spite of her being a well-respected teacher with good experience in PBL. Gabby seemed to leave the PD with a firm grasp on metacognition, as she was thoughtful as to how she could implement metacognitive strategies. She described her feelings as needing to be intentional in helping students recognize the skills they need to be successful in learning, "get students to recognize that the skills that they need to be successful in the learning process, as a teacher [I] have to be much more intentional in what [I'm] doing and saying to help them through that process." Additionally, she left the PD with a self-perceived use of metacognitive strategies.

Her enthusiasm however devolved as she moved forward with the curriculum, as she said "it was harder than I thought it would be with them." Towards the end she felt less confident, and at times was confounding metacognition with self-regulation – focusing on metacognitive knowledge happening at the beginning of a unit and metacognitive regulation happening at the end of the PBL unit. She said the beginning is an awareness phase, "so for me I see it as an awareness at the beginning," while the end is regulating, students are "regulating themselves to be able to use it and put it together for your classroom project that they're doing." As an expert teacher, feelings of decreased confidence could have influenced her ability to go all-in. While she willingly participated in all three interviews, she was more hesitant in regards to other elements, such as having students complete the curriculum writing prompts and recording her class sessions with the Swivl.

Mike

Always a deep thinker, Mike is quick to listen and ponders topics longer than most. He is a respected, experienced teacher and is a veteran at Project-based Learning, which had both beneficial and detrimental effects on his participation in this study. His propensity for deep thinking and his prior experience primed him well to be an excellent participant in the metacognitive PD and PBL curriculum implementation. However, his prior experience with PBL somewhat diverted his implementation of the curriculum – feeling he was not natural when implementing a "canned lesson." Similarly, at times he described a dearth of confidence when it came to metacognition and facilitating it with students.

As the study progressed, Mike's confidence did not seem to rebound as related to metacognition, suggesting he needed to apologize "for not doing that better" as he struggled with sticking with the "script." Combine this with his feelings of the curriculum being "canned," and it resulted in him not being as willing to go "all-in" on the study – including implementing metacognitive strategies as well as recording class sessions with the Swivl – this is evidenced by his relatively low fidelity score for implementing the curriculum. Additionally, at times, he related metacognition to something that all students *can* do, they just might choose not to, as he related metacognitive knowledge struggle, "I don't want to say laziness but just not willing to utilize the procedures that they already knew, you know they know what they are, they just choose not to use them." This is in spite of his eager and active participation in the metacognitive PD events, and his high self-perceived use of metacognitive strategies.

Nina

Qualified and thinker are adjectives that accurately describe Nina and her teaching style. However, she seemed hesitant to apply metacognition throughout the study, feasibly because she

was unable to find a place conceptually where she felt comfortable with it. This is in spite of her initially displaying enthusiasm consistent with her persona as an educator: willing to try new things and learn challenging ideas, as she described the value of metacognition, "if we all just stopped and [had] a little bit more understanding and training…we would see a big difference in our classrooms." Both her participation in the metacognitive PD elements and her self-perceived use of metacognitive strategies indicate she began the study with a solid conceptualization of metacognition.

However, as she progressed into the first few days of curriculum implementation, her reservations became more apparent. After the PD, her focus was on hesitantly trying out metacognitive facilitation, "I learned a lot, but I walked away thinking I really need to learn more." This potentially indicates self-efficacy concerns arose when attempting to operationalize metacognitive facilitation. Not long after starting the PBL curricular units, she decided to discontinue the implementation, citing difficult school conditions as the main motivator for the decision (i.e., multiple students enrolled in the course withdrawing from school).

While her reservations in her ability to be comfortable and smooth with metacognition may have influenced her decision to not finish curriculum implementation, she did complete the third round interview. In that third interview, she described still finding value in metacognition but needing more reinforcement and refinement of the idea in order to attain a higher comfort level with it.

Tim

A veteran, respected teacher, Tim was a unique participant in the study in that he is masterful when it comes to content knowledge. Likely, he was teaching with a Project-based instructional design years before this study. As he progressed through the PD and curriculum

implementation, Tim expressed confidence in metacognition and PBL, as he characterized his feelings about metacognition with a hint of dismissal, “metacognition is fine.” However, he frequently related metacognition to elements of cognitive learning, like a student’s ability to relate newly learned information to other topics, “and gives that opportunity for kids to have the realisticness and the building upon situation and, and to use it to where they're going to have the opportunity to just keep learning and falling back on things.” Relatedly, after curriculum implementation he suggested students tend to be most metacognitive at the end of a unit, when they are putting knowledge together “because we're starting to put [previous learning] together.” Finally, he often expressed the idea that metacognition was an avenue for developing deeper thinking, or learning that would be for the “long-term.” Tim’s mixed perceptions of metacognition was further evidenced by the scores on his students’ writing artifacts, as they varied as the study progressed (see Table 5.1).

Another factor in Tim’s participation was his extensive experience with PBL, and the main topic of the PBL units in this study (i.e., food science). Often, he would start and stop the curriculum to implement his own topics and activities, limiting the fidelity in which the curriculum and metacognitive strategies were utilized. His fidelity score evidenced this, as it was the lowest of all the teacher-participants.

Table 5.1 *Metacognitive Knowledge and Regulation Means for Student Writing Artifacts*

Participant	**Food for Thought Prompt 1 Means**	**Food for Thought Prompt 2 Means**	**Beef, it’s what’s for Dinner Prompt 3 Means**	**Beef, it’s what’s for Dinner Prompt 4 Means**
Cindy			2.6/4.20	1.29/3.71
Nina				
Mike	1.63/2.25		1.80/3.40	0.75/2.63

Gabby				
Tim	2.33/2.67	1.71/3.0	3.06/3.93	
Andrea	2.57/3.29	0.63/3.63	1.63/3.75	1.10/3.70

Note. Means are displayed as Metacognitive Knowledge mean / Metacognitive Regulation mean. Also, missing scores indicates no writings were submitted by that teacher-participant.

Key Findings

How does knowledge of metacognitive strategies influence teacher perception of the learning process in a PBL instructional environment?

When examining how metacognitive strategies influenced teacher-participants' perceptions of the learning process, four themes stood out from the rest: *beliefs on teaching*, *PBL benefits*, *metacognitive feelings*, and *teacher expectations*. *Beliefs on teaching* detailed teacher-participants' ideas and attitudes on instruction, including the need for relevancy and discovery, and who is responsible for learning. *PBL benefits* was built around the notion PBL is beneficial for students, as teacher-participants saw it as a way to engage and keep students accountable. Next, how teacher-participants felt about metacognition was explored in *metacognitive feelings*, including teacher-participant attitudes toward it and self-confidence to facilitate it. Finally, *teacher expectations* was centered on the expectations teacher-participants had for students and themselves as teachers. Much of how teacher-participants viewed metacognition was situated within their existing paradigms of the learning process and students, with teacher-participants holding themselves accountable for student learning as the prism through which they view instructional techniques. Following is a discussion of how metacognition both fit within those paradigms and challenged those paradigms.

When teacher-participants began the study (i.e., before any metacognitive PD with the researcher), the paradigm most commonly posited by them placed much emphasis on the need

for engagement, relevance, and accountability for students, as Tim offered an emblematic idea about relevancy and its importance, “relevancy plays a very crucial role” and activities need to be “beneficial for them throughout life.” This focus carried over to teacher-participant beliefs and attitudes after undergoing metacognitive PD. However, teacher-participants situated metacognition into their existing paradigm and represented metacognitive thinking as a way to accomplish those necessities. Metacognition became a way to hold students accountable by challenging their thinking, or metacognitive ability was viewed partially as a student’s ability to see the relevance in what was being learned, as Tim suggested a metacognitive regulatory learner is one who asks questions about broader impacts, “what is the long term effect of these types of things going on? How's it going to affect [outside markets]?” Situating metacognition into existing paradigms also may have affected how teacher-participants viewed metacognition and PBL as being similar – teacher-participants highly value PBL, suggesting it adds accountability and engages students, and those beliefs may have bled into metacognition since PBL was also an integral component of this study.

While teacher-participant beliefs and understandings of metacognition at times did not align with how metacognition is conceptualized by metacognition theorists, metacognition was still highly valued. In addition to previously discussed benefits of accountability, some teacher-participants saw metacognition as a way to build resiliency within their students, as metacognition was viewed as being related to, or enhancing, self-efficacy of students. It was posited that a metacognitive learner would be more likely to believe in his/her abilities, and have an expectation of success – but also not back down when something did go wrong, as Andrea postulated a metacognitive regulatory learner is one who is more confident because they “realize that they're doing things right. Or, if they're not, they're able to go back and look at where maybe

they didn't, weren't so successful, and change that habit for the future." Venturing further, teacher-participants seemingly implied self-efficacy was a pre-requisite for metacognitive thinking, at times describing a metacognitive student as one that meets the parameters of being self-efficacious. Gabby provided a characteristic description when she discussed metacognitive struggle with students, as "it becomes a barrier that 'I can't do something.'"

Metacognition also proved to be a change mechanism in teacher-participant thinking, as they referenced how metacognition changed the way they viewed, or understood, student-learning success. Mike shared a comment that represents this idea well, when after the PD he said during an interview "but, I just don't think some kids have ever stopped to think about how they learn best and apply it to the next time." Additionally, metacognition was deemed valuable, as many referenced wanting to learn more, and all suggested they will continue it. Metacognition seemed to inspire change in how teacher-participants' viewed the learning process, and it also seemed to be confounded by previous teacher-participant paradigms toward the learning process. Thusly, a key finding is the need for metacognitive-focused PDs to deliberately incorporate discussion on how metacognition fits, and does not fit, within PD participants' current paradigms of teaching and learning.

How do teachers facilitate student learning in a PBL instructional environment before and after metacognitive professional development?

Three themes came to the forefront when exploring how teacher-participants facilitated student learning: *beliefs on teaching*, *PBL benefits*, and *facilitating metacognition.* How teacher-participants viewed metacognition and its facilitation was the emphasis of *facilitating metacognition*, with teacher-participants citing ideas such as having higher expectations for students and asking more questions. Following is a discussion on how teachers valued

metacognition enough to make adjustments to how they facilitated learning, but those adjustments were somewhat thwarted by partial conceptualizations of the complex metacognitive process.

Teacher-participants, to a person, saw benefit in metacognitive usage by students enough to make adjustments in how they taught. Those adjustments included changing the types of questions they asked, how they worked with struggling students, and how they coached students. One example of how metacognitive PD influenced teacher-participants' beliefs on teaching was their reference to facilitating metacognition by increasing their expectations of students. On several occasions, it was mentioned that an awareness of metacognition by the teacher would enable them to challenge student thinking, and allow the teacher to expect more from the student. Some teacher-participants postulated challenging students to be in charge of their own learning would do this, directing and regulating their thinking on their own without the teacher doing it for them. For instance, Andrea suggested struggle (with regards to metacognition) is not something she would shy away from with her students, "frustration in my classroom is not a problem for me. I expect it, and I hope for it most of the time."

However, their conceptualization of metacognition was a limiting factor in how they attempted to facilitate metacognition. Oftentimes teacher-participants failed to differentiate between elements of metacognition and PBL, citing metacognition as a way to enhance student accountability and topical relevance – the same ideas surfaced when teacher-participants discussed why they saw PBL as beneficial. Cindy offered an illustrative thought when she discussed how metacognition could work within PBL projects, "it is up to [them] how [they] want to study, use [their] time to study this information, or put this presentation together." This idea of metacognition being an avenue to hold students accountable is another example of an

intertwining of PBL and metacognition in teacher-participants' minds, as they also suggested PBL would hold students accountable. This confusion may have contributed to teacher-participants somewhat viewing metacognition as an oversimplified strategy or teaching method, specifically when thinking of metacognition as an avenue to help them be better instructors or to aid their students in achieving higher order thinking about instructional content.

Further, when exploring how teacher-participants viewed their roles in metacognitive processing, they at times focused on how they would drive the process – somewhat similar to how they saw metacognition as a way to help them be better instructors. This is in juxtaposition with the conceptualization of metacognition as an internal, student-driven thinking process. Teacher-participant views of teaching and learning, and their feeling of responsibility for ensuring learning happens, may have influenced this notion. Metacognition was viewed, at times, as a one-off strategy they would employ to get students to think differently once or twice during an instructional unit. Teacher-participants tended to focus more on how they would drive the metacognitive process in the specific moments, and less on how they would develop systematic metacognitive ability within learners that the learners could then employ on their own, as Mike highlighted "being aware of the points in your instruction where [metacognition] can be incorporated, or to be pointed out."

What are educators' interpretations of student metacognitive regulation and knowledge during a PBL instructional environment?

When examining how teacher-participants interpreted student metacognition usage, two main ideas prevailed: *teachers' conceptualizations* and *teachers' partial conceptualizations.* Teacher-participants' discourse conveyed dichotomous messages: At times they hinted at a sound understanding of metacognition and described student use in accurate detail (i.e., *teachers'*

conceptualizations); however, those accurate descriptions were interspersed with partial understandings that confounded metacognition with effective or improved instruction (i.e., *teachers' partial conceptualizations*) or cognitive understanding.

As suggested in the discussion of key findings in previous research questions, teacher-participants had accurate conceptualizations of parts of metacognition. One of these was a clear understanding of metacognitive declarative knowledge, or the knowledge one has of themselves as a learner. Mike postulated an emblematic statement when he discussed a student who is successful at metacognitive knowledge as one that is quicker to achieve mastery because of their "previous experience on how they know they learn best." Frequently, teacher-participants cited the need for metacognitive declarative knowledge in the learning process, even describing how they would identify a student who struggles with it. Somewhat less frequent were discussions of ways to help students increase said knowledge. Teacher-participants at times focused on avenues for attaining declarative knowledge about their learners for themselves, not fully recognizing the benefit of having a student take a learning inventory so the student can then understand more about their own ways of thinking.

Teacher-participants' entangled thoughts of PBL and metacognition may have contributed to a somewhat common view of metacognition as cognitive understanding and elements of behaviors of a 'good student' (i.e., engaged in the activity and making connections with the content from day to day). This was evidenced when Tim described metacognitive struggle as a "student is not as structured or as hard working I guess I would say, or engaged as we'd like to see." Continuing, teacher-participants commonly focused on students who made connections with content and were able to understand things quickly as being metacognitively advanced. While elements of these ideas may prove in alignment with metacognition literature,

their experiences potentially underscore an imperfect understanding of all of the metacognitive components. Specifically, in reference to 'good student' beliefs, engagement highlights the outward appearance of a student, representing the doing, but ignores the mental processes the student is conducting. A student may be a willing participant, but may or may not enact metacognitive regulation based on metacognitive knowledge they may or may not possess.

How do teachers view their roles in influencing student metacognition?

Three themes inform the discussion related to how teacher-participants view their roles in influencing student metacognition, *beliefs on teaching*, *metacognitive feelings*, and *teacher expectations.* While teacher-participants view metacognition as desirable, at times they conveyed a lack of self-confidence to foster its use by their students. Other disparate notions were also suggested, as teacher-participants at times considered metacognition achievable by any of their students, and at other times described it as something done by only certain students.

Teacher-participants connected well with metacognition in that they found it valuable after learning about it and attempting to facilitate it, with Cindy summarizing metacognitive benefits well when she offered, "so that way your students are better learners." However, their experiences of influencing metacognition within students potentially illuminates a new need – additional PD as they implement metacognitive strategies in their classes. It seems teacher-participants connected well enough to see value, but not well enough to differentiate the more subtle aspects of metacognition (i.e., whether all students can enhance their metacognitive skills). A representation of this was when Cindy referred to needing to have certain students in order for her to easily have an impact on metacognition, "given the right students, it's easy to do." This is in alignment with key findings from other research questions – in essence, teacher-participants'

experiences with metacognition indicate a potential need for further refinement of conceptualization, operationalization, and implementation.

Potentially, self-efficacy was a limiting factor for some teacher-participants, preventing them from going "all-in" with metacognition. They valued it, and wanted to do it, but did not feel comfortable enough to try to facilitate it outside of a few instances scattered in their instruction. In a similar vein, teacher-participants' perceptions of students may also have impacted whether they went "all-in," as multiple references were made about students having the ability to do metacognition already, but choosing not to. With this allusion to student laziness, teacher-participants may have overestimated students' ability to think metacognitively, deciding students did not need help with learning metacognitive strategy use.

Discussion

Four main points of discussion emerge from the key findings. First, metacognition appeared to be a complex topic that challenged the existing paradigms of the teacher-participants in this study. Second, even though teacher-participants were metacognitively aware following the PD, they struggled with operationalizing and facilitating it. Third, based on these teacher-participants' experiences, more PD may be needed for complex topics like metacognition. Lastly, experiences of teacher-participants suggest PD on metacognition could have utility for other educators, as well.

Metacognition and Challenging Paradigms

Metacognition appears to be such a complex topic that it challenges teachers' existing paradigms about teaching and facilitating the learning process. This presents tremendous opportunities and challenges. Unlike other PD events, such as a new questioning strategy or new information on technical content that fits within teachers' existing paradigms, metacognition

seems to challenge teacher thinking and understanding of how they currently view learning. As a result, teachers may be faced with multiple instances after the initial PD where their understandings of learning and teaching are thrown into disequilibrium. While this is not necessarily a bad thing, it presents opportunities for knowledge of metacognition to then become fragmented, as teachers fill in gaps of understanding with previous knowledge (i.e., negative transfer, or interference), resulting in partial conceptualizations of metacognition. This idea of a complex topic and its impact on teacher change is parallel with what Hoekstra, Brekelmans, Beijaard, and Korthagen (2009) posited following a study with teachers in an informal, year-long learning environment focused on promoting teacher conceptualizations and behavior change as it relates to student active and self-regulated learning (ASL). Researchers postulated the new focus on ASL represented a major change to the traditional student-teacher interaction, and was a difficult concept for teachers. Further, the authors suggested an introduction of a new subject matter concept might present less of a challenge to teachers' already formed ways of thinking when compared to a more complex and abstract concept (Hoekstra et al., 2009).

Potentially, this has wider implications in practice as well. How often are teachers presented with a PD event where they are expected to grapple with a topic that may, or may not, fit within their existing paradigm? After the PD, and as they progress through the Model of Teacher Change stages, what happens when they are confronted with an element of their old belief system and an element of their developing system? For teacher-participants in the present study it seems they blended elements of their old system with elements of their new. One possible implication for PD events targeted for secondary school educators is to re-consider how those events are structured. Can we take measures, such as maybe having multiple sessions at different stages in the Teacher Change Model, to help teachers navigate the formation of new

paradigms? Specifically, with regards to metacognition future PD offerings may need to account for the perceived complexity of the topic, and consider incorporating more scaffolding opportunities for educators undergoing the PD.

Recommendations for research also emanate from the perceived complexity of metacognition. In the present study, teacher-participants described a partial understanding of metacognition. Future research could explore variables that may have affected that understanding, such as PD structure and teacher prior knowledge, among others. Future research could also explore teachers' acquisition of metacognitive understanding, potentially seeking to determine the most effective PD structure by quantifying teachers' knowledge increase with the aid of metacognitive inventories like the MAI.

Metacognitively Aware, but Facilitation Troubles

As teacher-participants left the Metacognitive PD event, they described an understanding of metacognition and of being metacognitively aware. They could define elements of metacognition, and provide examples of what metacognitive knowledge and/or regulation struggle and success looked like with their students. Put simply, they knew what metacognition was and how they utilized it for themselves. However, despite that metacognitive awareness, as the study progressed they began to struggle with operationalizing and facilitating metacognitive activities with their students.

When attempting to operationalize metacognition with their students and facilitate it, they would frequently begin focusing on metacognition as a higher-order learning activity, confuse it with making outside connections to current learning, or just feel overwhelmed. In essence, they knew metacognition well enough to describe it, but not well enough to facilitate it. At times, teacher-participants admitted their feelings of facilitation struggles, as Nina openly suggested she

still needed to learn more following the PD event. Teacher-participants struggled with taking a concept (metacognition) they could define and facilitating it with their students. This is not unlike other topics educators teach, where one may understand a topic for his/her own benefit, but not grasp it fully enough to teach it to others. The disconnect between an awareness of metacognition, and an ability to facilitate it with students, leads me to the next discussion point.

One substantial research recommendation highlighted by this revelation is incorporating a third party observation to gauge teacher application of metacognitive strategies. This would also allow for observation of metacognitive thinking by students. Further, data collected could inform follow-up PD, basing the PD structure on elements of metacognitive facilitation teachers are struggling with and reinforcing elements done successfully.

Additional PD for Complex Topics

When learning about an idea that challenges existing paradigms on learning and teaching, more PD may be needed as teachers progress through the stages of the Guskey (2002) Model of Teacher Change. Specifically, additional professional development taking place after teachers have experimented with implementing new knowledge from the initial PD experience, but before they have the opportunity to solidify new beliefs, could be warranted. While the metacognitive PD succeeded in increasing teacher-participant awareness and interest in metacognition, they struggled with how metacognition fit within their existing paradigms and how they were going to facilitate it. New questions arose after metacognitive interventions were tried for the first time, and in the absence of information, teacher-participants filled gaps in conceptual understanding with what they already knew about learning and teaching.

Research exists that advocates for longer PD experiences, as five critical features of effective PD have been identified: 1) content focus, 2) active learning, 3) coherence, 4) duration,

and 5) collective participation (Desimone, 2011; Garet, Porter, Desimone, Birman, & Yoon, 2001). Specifically, authors operationalized duration to have two elements, contact hours (i.e., amount of time spent focusing on a topic) and span (i.e., period of time that the activity took place) (Garet, et al., 2001). It was postulated PD extending over time allows for teachers "to try out new practices in the classroom and obtain feedback" (p. 922).

Based on these ideas, an adapted model for teacher change and complex topics is presented in Figure 5.1 below:

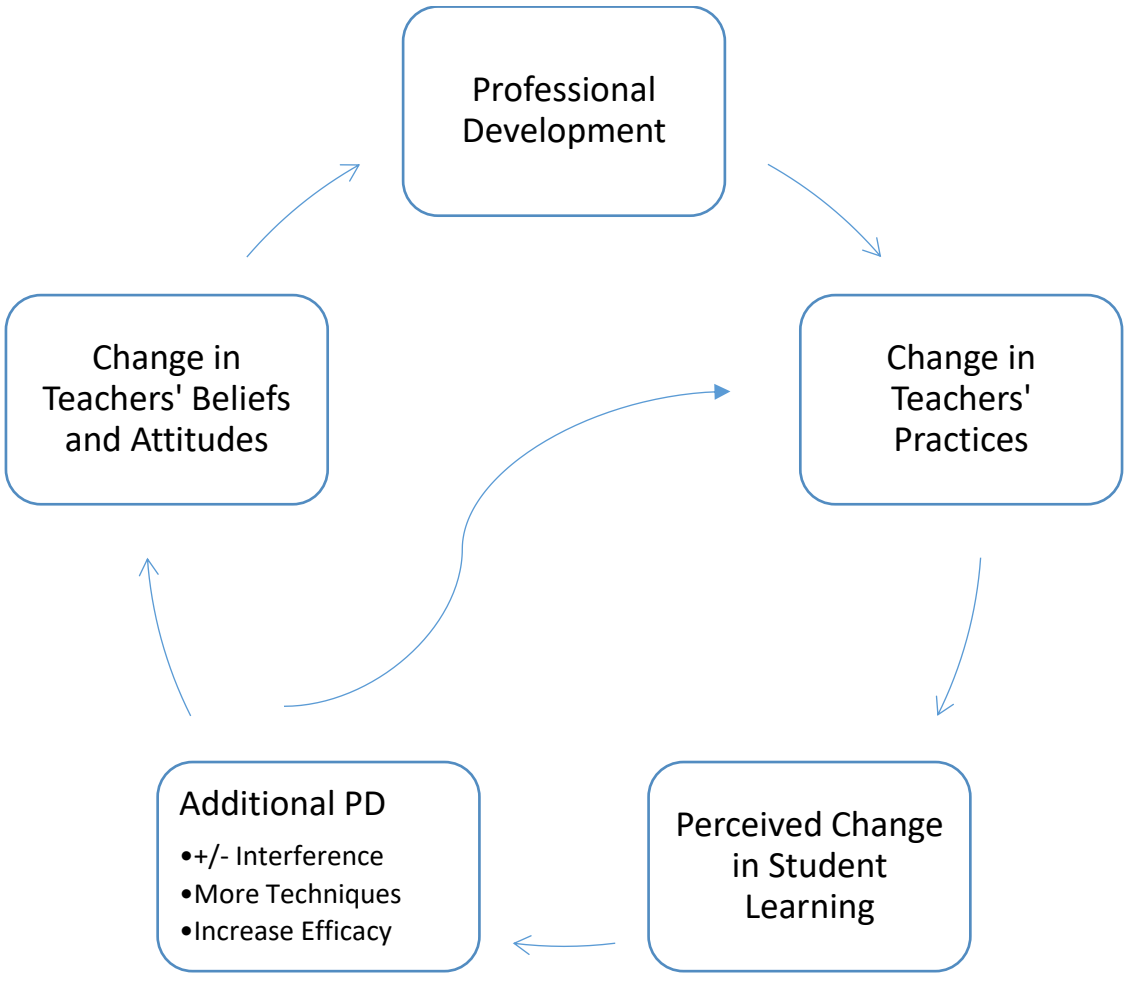

Figure 5.1 Model for Professional Development in Complex Topics, adapted from Guskey (2002)

In the original Guskey (2002) model, teachers would undergo a PD event, enact new practices learned during the PD, gauge student outcomes of new practices, and then ultimately decide whether to adjust their attitudes and beliefs. While teacher-participants' discourses affirm Guskey's model and its description of how teachers progress through change, the model does not account for additional PD events that may be needed for complex topics. Based on teacher-participants' experiences with metacognition and Garet et al.'s (2001) postulation that longer period PDs are important for teachers to have implementation and feedback opportunities, additional PD with metacognition might be warranted to further enable teachers to refine their conceptualization and operationalization of metacognition. After teacher-participants underwent metacognitive PD they had an understanding of what metacognition was, and some avenues for facilitating it with their students. However, as they attempted to facilitate it they were faced with challenges to their understanding, which ultimately resulted in negative interference (i.e., associating metacognition with other items that are similar, but not actually metacognition). As a result, when teacher-participants were assessing student outcomes and making changes to their beliefs and attitudes about teaching, they were doing so with partial conceptualizations of metacognition.

An adapted PD model accounting for the intricacies of a complex topic like metacognition would incorporate opportunities for application of metacognitive facilitation strategies. A revised PD model would include a longer span, allowing for PD events to occur after teachers have applied their new strategies and learning. The revised PD model would be a more iterative process that would allow teachers to gain new knowledge, practice applying it, see student outcomes, and have possible belief changes, all in a circular process that provides multiple learning opportunities. The revised model could provide teachers with an opportunity to

practice new ideas on teaching, but also offer the opportunity to revise and refine their understanding of the PD topic given its complexity. The additional PD offerings included in the lengthened span could focus on several potential areas: a) further analysis and application of metacognition facilitation strategies, including practice facilitating metacognitive-enhancing activities; b) refinement of conceptualization of metacognition, focusing on negating the impact negative interference has on teacher understanding, such as projecting PBL properties onto metacognition (e.g., an avenue to engage students); and c) further consideration of how metacognition may impact how learner success is viewed.

Further, an implication for practice related to metacognitive PD involves parsing PD out into three foci happening in multiple occurrences: 1) increasing awareness by focusing on what metacognition is; 2) exploring avenues for facilitating student metacognitive use; 3) refining metacognitive understanding and facilitation after initial implementation. Incorporating the revised model with this three part process may enable better metacognitive professional development for teachers.

Utility of Metacognition

After undergoing PD teachers saw value in metacognition and noted that it impacted how they viewed the learning process for the better. Additionally, teacher-participants' discussions support research with respect to teacher comprehension and understanding of metacognition before PD (Hughes, 2017; McKendree & Washburn, 2017; Seraphin et al., 2012), as well as Wilson and Bai's (2010) conclusion that even after PD teachers had contradictory understandings. Given metacognition's role in effective learning (Cross & Paris, 1988; Gourgey, 1998; Pate & Miller, 2011; Pintrich, 2002; Wang et al., 1990), metacognition should continue to be explored as a PD opportunity within secondary education.

Additionally, given the proclivity of teachers to be unaware of metacognition, postsecondary teacher education programs should consider adopting metacognitive instruction into their programs. This instruction should be framed similar to metacognitive PD for in-service teachers, and should have multiple opportunities for preservice teachers to engage with, facilitate, and reflect on metacognitive strategy use. Incorporating metacognition into preservice programs would allow preservice teachers to practice facilitating it with students, and more time to further refine their understanding and adjust their paradigm on teaching and learning accordingly.

In addition to the future research needed to examine the structure of metacognitive PD we discussed previously, further research may be needed to explore the most effective PD methods for metacognition. This could potentially include exploring a revised model for complex topics (see Figure 5.1) that involves multiple PD opportunities before and after attempts to facilitate. Teachers, and their students, could then be assessed with a self-report of metacognitive awareness, such as the metacognitive awareness inventory (Schraw & Dennison, 1994). Subsequently, research could examine the impact professionally developed teachers have on their students' achievement. Research could also explore metacognitive usage by post-secondary students. Students could be exposed to a metacognitive intervention (e.g. regulatory checklist) throughout the semester, and complete pre and post surveys to assess their metacognitive thinking. Survey scores indicating metacognitive thinking could then be analyzed with academic achievement in the course.

Finally, further inquiries into metacognition instruction in preservice teacher education programs could be made. Given the importance of metacognition in student learning, and the current suggestion that teacher facilitation of metacognition is impacted by, and is an influencer

of, teaching and learning paradigms, metacognitive instruction should potentially be incorporated into preservice programs. Initial research could explore how metacognitive instruction impacts preservice teacher achievement in teacher preparation programming. Future studies could then explore how metacognitive instruction impacts preservice teacher paradigms of the learning process.

References

Albert Einstein Quotes. (n.d.). Retrieved from https://www.brainyquote.com/quotes/albert_einstein_108304

An, Y. J., & Cao, L. (2014). Examining the effects of metacognitive scaffolding on students' design problem solving and metacognitive skills in an online environment. *Journal of Online Learning and Teaching*, *10*(4), 552.

Anderson, R. D. (2002). Reforming science teaching: What research says about inquiry. *Journal of Science Teacher Education, 13*(1), 1-12.

Barron, B. J., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., & Bransford, J. D. (1998). Doing with understanding: Lessons from research on problem-and project-based learning. *Journal of the Learning Sciences, 7*(3-4), 271-311. doi:10.1080/10508406.1998.9672056

Bell, R.L., Smetana, L., & Binns, I. (2005). Simplifying inquiry instruction. *The Science Teacher, 72*(7), 30-33.

Bhattacharya, K. (2008). *Introduction to qualitative methods: A student handbook*. Corpus Christi, TX: Bhattacharya.

Bidjerano, T. (2005). Gender differences in self-regulated learning. Paper presented at the *Annual Meeting of the Northeastern Educational Research Association,* Kerhonkson, NY. Retrieved from http://search.proquest.com/docview/62084543?accountid=11789

Blackburn, J. J., & Robinson, J. S. (2016). Determining the effects of cognitive style, problem complexity, and hypothesis generation on the problem solving ability of school-based agricultural education students. *Journal of Agricultural Education, 57*(2), 46-59. doi:10.5032/jae.2016.02046

Blumberg, P. (2000). Evaluating the evidence that problem-based learners are self-directed learners: A review of the literature. In D. H. Evensen, & C. Hmelo-Silver (Eds.), *Problem-based learning: A research perspective on learning interactions* (pp. 199). Mahwah, N.J.: Routledge. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=45444&site=ehost-live

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*(3-4), 369-398.

Blumer, H. (1969). *Symbolic interactionism: Perspective and method*. Englewood Cliffs, NJ: Prentice-Hall.

Brown, A. (1987). Metacognition, executive control, self-regulation, and other more mysterious mechanisms. In F. E. Weinert, & R. H. Kluwe (Eds.), *Metacognition, motivation, and understanding* (pp. 65-116). Hillsdale, N.J: L. Erlbaum Associates.

Brown, A., Bransford, L., Ferrara, R., & Campione, J. (1983). Learning, remembering and understanding. In P. H. Mussen (Ed.), *Handbook of child psychology* (4th ed., pp. 77). New York: John Wiley and Sons.

Burton, E. P. (2012) Using metacognition to develop understanding of the role of evidence in science. *Science Scope, 35*(9), 14-19.

Chinn, C. A., & Malhotra, B. A. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education, 86*(2), 175-218.

Cikrikci, Ö., & Odaci, H. (2016). The determinants of life satisfaction among adolescents: The role of metacognitive awareness and self-efficacy. *Social Indicators Research*, *125*(3), 977–990. doi:10.1007/s11205-015-086-5

Cockrell, K. S., Caplow, J. A. H., & Donaldson, J. F. (2000). A context for learning: Collaborative groups in the problem-based learning environment. *The Review of Higher Education, 23*(3), 347-363.

Crandall, D. P., Loucks-Horsley, S., Bauchner, J. E., Schmidt, W. B., Eiseman, J. W., Cox, P. L., Miles, M. B., Huberman, A. M., Taylor, B. L., Goldberg, J. A., Shive, G., Thompson, C. L. & Taylor, J. A. (1982) *People, policies, and practices: Examining the chain of school improvement.* Andover, MA: The NETWORK, Inc.

Cross, D. R., & Paris, S. G. (1988). Developmental and instructional analyses of children's metacognition and reading comprehension. *Journal of Educational Psychology, 80*(2), 131.

Davis, E. A. (2003). Prompting middle school science students for productive reflection: Generic and directed prompts. *The Journal of the Learning Sciences, 12*(1), 91-142. doi:10.1207/S15327809JLS1201_4

De Backer, L., Van Keer, H., Moerkerke, B., & Valcke, M. (2016). Examining evolutions in the adoption of metacognitive regulation in reciprocal peer tutoring groups. *Metacognition and Learning, 11*(2), 187-213. doi:10.1007/s11409-015-9141-7

Desimone, L. M. (2011). A primer on effective professional development. *Phi delta kappan*, *92*(6), 68-71.

Downing, K., Kwong, T., Chan, S., Lam, T., & Downing, W. (2009). Problem-based learning and the development of metacognition. *Higher Education, 57*(5), 609-621. doi:10.1007/s10734-008-9165-x

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist, 34*(10), 906.

Flavell, J. H., & Wellman, H. M. (1975). Metamemory. Paper presented at the *Annual Meeting of the American Psychological Association,* Chicago, IL.

Flick, U. (2009). *An introduction to qualitative research* (4th ed.). Thousand Oaks, CA: Sage.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American educational research journal*, *38*(4), 915-945.

Glaser, B. G. (1965). The constant comparative method of qualitative analysis. *Social Problems, 12*(4), 436-445.

Gordon, P., Rogers, A., Comfort, M., Gavula, N., & McGee, B. (2001). A taste of problem-based learning increases achievement of urban minority middle-school students. *Educational Horizons, 79*(4), 171-175.

Gourgey, A. F. (1998). Metacognition in basic skills instruction. *Instructional Science, 26*(1), 81-96.

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Ectj, 29*(2), 75-91.

Guskey, T. R. (1984) The influence of change in instructional effectiveness upon the affective characteristics of teachers, *American Educational Research Journal*, *21*(2), 245-259.

Guskey, T. R. (1986) Staff development and the process of teacher change, *Educational Researcher, 15*(5), 5-12.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching, 8*(3), 381-391. Retrieved from https://doi.org/10.1080/135406002100000512

Hmelo, C. E., & Lin, X. (2000). Becoming self-directed learners: Strategy development in problem-based learning. In D. H. Evensen, & C. Hmelo-Silver (Eds.), *Problem-based learning: A research perspective on learning interactions* (pp. 227). Mahwah, N.J.: Routledge. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=45444&site=ehost-live

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235-266.

Hoekstra, A., Brekelmans, M., Beijaard, D., & Korthagen, F. (2009). Experienced teachers' informal learning: Learning activities and changes in behavior and cognition. *Teaching and Teacher Education*, *25*(5), 663-673.

Hughes, A. J. (2017). Educational complexity and professional development: Teachers' need for metacognitive awareness. *Journal of Technology Education*, *29*(1), 25-44. https://doi.org/10.21061/jte.v29i1.a.2

Hung, W., Jonassen, D. H., & Liu, R. (2008). Problem-based learning. In J. M. Spector, M. D. Merrill, J. Van Merriënboer & M. P. Driscoll (Eds.), *Handbook of research on educational communications and technology* (pp. 485-506). 3rd Ed. New York, NY: Lawrence Erlbaum Associates.

Jacobs, J. E., & Paris, S. G. (1987). Children's metacognition about reading: Issues in definition, measurement, and instruction. *Educational Psychologist, 22*(3-4), 255-278.

Kluwe, R. H. (1982). Cognitive knowledge and executive control: Metacognition. In D. R. Griffin (Ed.), *Animal mind–human mind* (pp. 201–224). New York: Springer-Verlagg

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade science teachers learn project-based instruction. *The Elementary School Journal, 94*(5), 483-497.

Krajcik, J., Blumenfeld, P. C., Marx, R. W., Bass, K. M., Fredricks, J., & Soloway, E. (1998). Inquiry in project-based science classrooms: Initial attempts by middle school students. *Journal of the Learning Sciences, 7*(3-4), 313-350.

Ladewski, B. G., Krajcik, J. S., & Harvey, C. L. (1994). A middle grade science teacher's emerging understanding of project-based instruction. *The Elementary School Journal, 94*(5), 499-515.

Livingston, J. A. (2003). *Metacognition: An overview.* (ERIC Document Reproduction Service No. ED474273)

Lovett, M.C. (2013). Make exams worth more than the grade. In M. Kaplan, N. Silver, D. Lavaque-Manty, & D. Meizlish (Eds.), *Using reflection and metacognition to improve student learning* (pp. 18-52). Sterling, VA: Stylus Publisher, Inc.

Loyens, S. M., Magda, J., & Rikers, R. M. (2008). Self-directed learning in problem-based learning and its relationships with self-regulated learning. *Educational Psychology Review, 20*(4), 411-427.

Marx, R. W., Blumenfeld, P. C., Krajcik, J. S., & Soloway, E. (1997). Enacting project-based science. *The Elementary School Journal, 97*(4), 341.

McKendree, R. B., & Washburn, S. G. (2017). Effects of regulatory self-questioning on secondary-level students' problem-solving performance. *Journal of Agricultural Education, 58*(4), 144-161. https://doi.org/10.5032/jae.2017.04144

Merriam, S. (2002). *Qualitative research in practice: Examples for discussion and analysis* (1st ed., Jossey-Bass higher and adult education series). San Francisco: Jossey-Bass.

Metacognitive Awareness Inventory. (n.d.). Retrieved from https://services.viu.ca/sites/default/files/metacognitive-awareness-inventory.pdf

Myers, M., & Paris, S. G. (1978). Children's metacognitive knowledge about reading. *Journal of Educational Psychology, 70,* 680-690.

National Research Council. (2000). *How people learn*. Washington, D.C.: National Academy Press.

Noesgaard, S. S. (2016). Can E-Learning Change Work Practices? *International Association for Development of the Information Society*.

Paris, S. G., & Jacobs, J. E. (1984). The benefits of informed instruction for children's reading awareness and comprehension skills. *Child Development,* 55, 2083-2093.

Pate, M. L., & Miller, G. (2011). Effects of regulatory self-questioning on secondary-level students' problem-solving performance. *Journal of Agricultural Education, 52*(1), 72-84. doi:10.5032/jae.2011.01072

Pintrich, P. R. (2002). The role of metacognitive knowledge in learning, teaching, and assessing. *Theory into Practice, 41*(4), 219-225.

Reeve, R. A., & Brown, A. L. (1985). Metacognition reconsidered: Implications for intervention research. *Journal of Abnormal Child Psychology, 13*(3), 343-356.

Rogers, P. (2007). Teacher professional learning in mathematics: An example of a change process. In *Mathematics: Essential research, essential practice. Proceedings of the 30th annual conference of the Mathematics Education Research Group of Australasia* (pp. 631-640).

Schraw, G. (1998). Promoting general metacognitive awareness. *Instructional Science, 26*(1), 113-125.

Schraw, G. & Dennison, R.S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19,* 460-475.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education, 36*(1-2), 111-139.

Schwartz, N. H., Scott, B. M., & Holzberger, D. (2013). Metacognition: A closed-loop model of biased competition-evidence from neuroscience, cognition, and instructional research. In R. Azevedo & V. Aleven (Eds.), *International Handbook of Metacognition and Learning Technologies* (Vol. 28, pp. 79–94). New York, NY: Springer.

Seidman, I. (2013). *Interviewing as qualitative research: A guide for researchers in education and the social sciences* (4th ed.). New York, NY: Teachers College Press.

Seraphin, K. D., Philippoff, J., Kaupp, L., & Vallin, L. M. (2012). Metacognition as means to increase the effectiveness of inquiry-based science education. *Science Education International, 23*(4), 366-382.

Spindler, M. (2010). A taxonomic description of the science integrating learning objectives in career and technical education programs of study. *Career & Technical Education Research, 35*(3), 157-173. doi:10.5328/cter35.312

Stryker, S. (1976). 'Die theorie des symbolishchen interaktionismus,' in M. Auwarter, E. Kirsh and K. Schroeter (eds), *Seminar, kommunikation, interaktion, identitat*. Frankfurt: Suhrkamp, pp. 257-74.

Sungur, S., & Tekkaya, C. (2006). Effects of problem-based learning and traditional instruction on self-regulated learning. *The Journal of Educational Research, 99*(5), 307-320.

Thomas, J. W. (2000). A review of research on project-based learning. San Rafael, CA: Autodesk Foundation.

Thomas, G. P., & Anderson, D. (2014). Changing the metacognitive orientation of a classroom environment to enhance students' metacognition regarding chemistry learning. *Learning Environments Research*, *17*(1), 139–155. doi:10.1007/s10984-013-9153-7

Thoron, A. C., & Myers, B. E. (2011). Effects of inquiry-based agriscience instruction on student achievement. *Journal of Agricultural Education, 52*(4), 175-187. doi:10.5032/jae.2011.04175

Veenman, M. V., Van Hout-Wolters, B. H., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning, 1*(1), 3-14.

Veenman, M. V. J., Wilhelm, P., & Beishuizen, J. J. (2004). *The relation between intellectual and metacognitive skills from a developmental perspective* doi:https://doi-org.proxy1.cl.msu.edu/10.1016/j.learninstruc.2003.10.004

Wang, M. C., Haertel, G. D., & Walberg, H. J. (1990). What influences learning? A content analysis of review literature. *The Journal of Educational Research, 84*(1), 30-43.

White, B., Frederiksen, J., & Collins, A. (2009). The interplay of scientific inquiry and metacognition: More than a marriage for convenience. In D.J. Hacker, J. Dunlosky, & A.C. Graesser (Eds.), *Handbook of metacognition in education* (175–205). New York, NY: Routledge Taylor & Francis Group.

Wilson, N. S., & Bai, H. (2010). The relationships and impact of teachers' metacognitive knowledge and pedagogical understandings of metacognition. *Metacognition and Learning, 5*(3), 269-288. doi:10.1007/s11409-010-9062-4

Young, A. E. (2010). *Explorations of metacognition among academically talented middle and high school mathematics students.* Berkeley, CA: University of California.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice, 41*(2), 64. Retrieved from: http://search.ebscohost.com/login.aspx?direct=true&db=tfh&AN=6834387&site=ehost-live

Zimmerman, B.J. & Martinez-Pons, M. (1990). Student differences in self-regulated learning: relating grade, sex, and giftedness to self-efficacy and strategy use. *Journal of Educational Psychology, 82*(1),51–59.

Zohar, A., & Barzilai, S. (2013). A review of research on metacognition in science education: Current and future directions. *Studies in Science Education, 49*(2), 121–169.

Zohar, A., & David, A. (2008). Explicit teaching of meta- strategic knowledge in authentic classroom situations. *Metacognition and Learning, 3*(1), 59-82. doi:10.1007/s11409-007-9019-4

Appendix A - Letter Inviting Teachers to Participate

Hi ___,

I hope all is well at the end of your school year! You may have seen an email from me earlier in this school year asking for you to participate in my dissertation study. I am very happy to report my committee has given me approval to continue with my study, but the current plan does represent some changes from the original format in my previous email. I would still love for you to participate in this study if you can!

Following below is a rundown of the research, and how I would welcome your participation. Because of the commitment I am asking from you, before you deny or confirm your willingness to help, I would love for us to have a phone conversation anytime around the weeks of June 4th to June 15th. Please let me know when a good time would be for us to connect and I can answer any questions you may have. I am VERY excited about this study, and I think it provides an opportunity for us both to learn while doing it.

Description of study:

My dissertation will focus on metacognition and how teachers perceive it within their students. It will involve a series of three short interviews between you and I over Zoom, and you teaching two units of the FNS curriculum to a class of your choosing (Food for Thought and Beef It's What's for Dinner). Incorporated in the study will be a hybrid online/in person professional development event focused on metacognition where you will have the opportunity to receive continuing education hours. The professional development will have two components, three short online modules (about 30 minutes apiece), and an in-person event. The in-person

professional development will take place at the end of summer K-ACTE conference, on August 1, 2018 in Manhattan. I am happy to offer you a one-time stipend of $200 for participating in the study and coming to the PD, as well as offering to cover your meals for August 1st and your hotel room for the night of July 31st.

Timeline:

Mid-Late June	1st Zoom interview (time and location your choice)
Early July	Online modules released to participants (3 short modules accessed via Canvas at KSU – it is free to use)
August 1st	In-person professional development at end of Summer K-ACTE conference in MHK (room/food provided)
August	2nd Zoom interview (time and location your choice)
Fall semester	You implement 2 FNS units in class of your choosing Record a few class sessions during each unit (we will loan you the technology for recording)
November/December	3rd Zoom interview (time and location your choice)

Again, I am very thankful for your consideration of this fun opportunity for us to work together. I look forward to hearing from you regarding a phone conversation,

Buddy

Appendix B - Online Metacognitive Professional Development Outline

Condensed Online Outline:

What is metacognition?

Metacognitive Knowledge (MK) (Module 1)

Metacognitive Regulation (MR) (Module 2)

Why is it important? (Module 3)

Expanded Online Outline:

I. What is metacognition? – "thinking about our thinking" or regulating and directing one's own thinking and learning (Hughes, 2017). Contains two main elements: metacognitive knowledge and metacognitive regulation (Brown, Bransford, Ferrara, & Campione, 1983; Jacobs & Paris, 1987; Kluwe, 1982; Livingston, 2003; Schraw, 1998).

   A. Module 1 Metacognitive Knowledge – knowing about things, how to do things, and when/why to do them (Jacobs & Paris, 1987).

      i. Declarative

         1. Knowledge *about* things, (good learners appear to have more knowledge about different aspects of memory such as capacity limitations, rehearsal, and distributed learning)

            a. such as yourself as a learner.

               i. Student Example: Difficulty remembering names (so use King Phillip Came Over From Greece Singing Songs)

ii. Teacher Example: I have trouble with remembering to use positive praise (so I tie a string on my finger as a reminder)

b. About human brain in general.

i. Student Example: Studying at the last minute is not effective and most information will not be retained (so spread studying out)

ii. Teacher Example: Brain can only handle 5-9 bits of information at one time (so organize and structure learning to accommodate this) (Sousa, 2017)

ii. Procedural

1. Knowledge of *how* to do things

a. Knowledge of processes, such as study skills

i. Student example: How to use the INSERT strategy when reading a new article for first time.

ii. Teacher example: How to "chunk" new information in lessons.

iii. Conditional

1. Knowing *when* and *why* to use declarative/procedural knowledge

a. The "search engine" for the brain depending on the conditions of the learning. Also knowing why strategies work/not.

i. Student example: Mnemonic devices work because they help us develop an association for otherwise random bits of information (acronym/letters) (WHY).

ii. Teacher Example: Knowing the need to utilize reflection on lesson effectiveness after seeing low exam scores for students (when).

Reading assignment: *Metacognition Overview* pdf and *Vanderbilt Center for Teaching_Metacognition* pdf. [These articles are intended to provide teacher-participants with another introduction to the concept of metacognition.]

Reading Questions:

1. Using the *Metacognition Overview* pdf, how would you describe metacognition to your building principal?
2. When do you think metacognition can be applied in the classroom? How often?
3. Which concept or component of metacognition are you struggling with? Why?

B. Module 2 Metacognitive Regulation – used to "regulate and oversee learning" (p. 107), and includes regulatory activities such as planning, monitoring, evaluating, and revising (Brown et al., 1983)

i. Planning

1. Activities/strategies undertaken before a learning opportunity

a. Student example: mapping elected study strategies one week before an exam (rote memorization with index cards, followed by INSERT reading strategy on past passages, followed by summary-writing of key concepts)

b. Teacher example: Mapping out items to look for in an upcoming PD event (focusing on usefulness during presentation and then engaging in practice activities afterwards).

ii. Monitoring

1. Activities/strategies utilized during a learning opportunity

a. Student example: Highlighting key points while reading a passage; monitoring study efficiency by reflecting on amount covered after the completion of 1-hour intervals.

b. Teacher example: tracking the quality of questions you ask during your lesson by recording yourself (or asking a colleague to sit-in on a class).

iii. Evaluating

1. Activities/strategies employed before, during, and/or after a learning opportunity – elements don't happen in a perfectly linear fashion, you may hop around!

a. Student example: Using previously-described highlighting, students make a judgement on how well they know the material their highlights have deemed important.

b. Teacher example: watching the previously-described video of their teaching, teacher assesses the quality of their questions looking for key elements like wait time, open versus closed, and directed versus undirected.

iv. Revising

1. Continuing the evaluating activities/strategies further into actual adjustments.
    a. Student example: Student decides they are lacking full understanding of key concept #2, and adjust study direction to focus more on that concept.
    b. Teacher example: Teacher realizes their questions are often closed-ended and don't have much wait time, so s/he starts writing questions out before each lesson. S/he also implements a monitoring strategy to help increase wait time (taps finger on leg 4 times after asking a question).

Reading Assignment: Read only the highlighted sections of *Self Questioning and Problem Solving* pdf [This article is intended to provide teacher-participants with more background on Metacognitive Regulation, and show an example of a regulatory checklist.]

Reading Questions:

1. Based on the study, why do you think students performed better with the regulatory checklist?
2. How can we apply this concept (regulatory checklist) for ourselves as educators?
3. How does a regulatory checklist fit with metacognitive regulation?

C. Module 3 Why is Metacognition important?

i. Success Academically – Different studies have revealed the importance of metacognitive elements:

1. Agricultural mechanics students using a self-questioning protocol (metacognitive strategy) on an electrical circuit test scored 10% higher than students who did not utilize the self-questioning protocol (Pate & Miller, 2011)
    a. This included a focus on both metacognitive knowledge (knowing how to do the strategy) and metacognitive regulation (form of monitoring and evaluation strategy)
    b. Key takeaway for teachers: Even explicitly incorporating one metacognitive strategy can be impactful for students
2. A component of metacognition, Self-Regulated Learning, was found to be a better predictor of academic success than socioeconomic status and gender (Zimmerman & Martinez-Pons, 1986)
    a. SRL focuses more on the oversight of learning, aligning more with metacognitive regulation
    b. Key takeaway for teachers: metacognitive processes can greatly influence the success of students. Our best students are likely metacognitively-oriented, and our weaker students are most likely lacking in metacognition.
3. Researchers employed an intervention that focused on changing the learning environment in a chemistry class by incorporating language such as the three-level framework (macroscopic, microscopic, and symbolic) (Thomas & Anderson, 2014).

a. Students became more metacognitively oriented, as they were continually asked to focus on *how* they were learning chemistry.
b. Key takeaway: We can influence students' use of metacognitive processes

ii. Life Satisfaction

1. Study correlated metacognition, life satisfaction, and self-efficacy among adolescents (Cikrikci & Odaci, 2016)
    a. Metacognitive awareness significantly positively correlated with life satisfaction
    b. Key takeaway for teachers: Metacognitive learners are often happy in life – maybe because they are successful in new endeavors?

Module 1 Discussion Question: How can we know if a student has/is using metacognitive knowledge? What indicators can we look at?

Module 1 Quiz:

1. Which of the following describes metacognition?
    a. Focusing only on facts to ensure accurate earning
    b. Regulating and overseeing one's own learning
    c. Using appropriate learning strategies to be a more efficient learner
2. Which of the following is an example of metacognitive declarative knowledge?
    a. Buddy is aware he struggles with striking an arc while welding.
    b. Buddy knows how to highlight important key points in a text.

c. Buddy performs poorly on a welding exam as his teacher notices he has trouble striking an arc.

3. You notice a student in your class seems to have trouble using learning strategies. They never seem to use the correct strategy, and it often results in them working hard but not doing well on exams. Finally, this last week you notice them trying to use a mnemonic device to remember vocabulary definitions. Which type of metacognitive knowledge is this student most likely lacking in?
    a. Declarative
    b. Procedural
    c. Conditional
4. A new teacher decides she wants to periodically teach her students new study strategies. She decides to teach self-evaluation first by discussing with her students how she does self-evaluation and then explains the necessary steps to doing a self-evaluation. Which type of metacognitive knowledge is she focusing on with her students?
    a. Declarative
    b. Procedural
    c. Conditional

Module 2 Discussion Question: How can we detect students' use of metacognitive regulation? What indicators can we look for?

Module 2 Quiz:

1. Metacognitive planning can best be described as:
    a. Mapping the learning strategies and mental processes to be used during a learning event.

b. Focusing on acquiring only the correct information.

c. Knowing when and why to use a learning strategy.

2. Buddy, a mid-career teacher, has been completing metacognitive training modules. He decides to enlist the assistance of his classroom aid to write down the number of times he says "um" during his lesson. What form of metacognitive regulation is this?

    a. Evaluation

    b. Planning

    c. Monitoring

3. You notice a student pausing while using the arc welder. Concerned he is up to no good, you decide to check-in to see how he's doing. You discover he actually paused welding because he noticed his weld was not laying properly, and he is inspecting it to make a decision if further steps need to be take. What form of metacognitive regulation is this student exhibiting?

    a. Monitoring

    b. Evaluating

    c. Revising

Module 3 Discussion Question: Given what we have learned from the three online modules, how do you feel about metacognition? What do you still want to know?

Appendix C - In-person Metacognitive Professional Development Outline

Condensed Outline:

In-person Workshop:

- Metacognition as a learner
- Metacognition as a Teacher
- Facilitating Metacognition with Students
  - Promote Metacognitive awareness
  - Improve Metacognitive knowledge
  - Improve Metacognitive regulation
  - Foster conducive environments

Expanded Outline:

I. In-person Professional Development

Introduction [45 minutes total]: [Group Discussion – 10 minutes] Begin with a review of Modules One, Two, and Three by asking the following questions:

What is metacognition? Knowledge? Regulation?

Why is awareness of metacognition relevant for teachers?

What is an example of declarative knowledge? Procedural? Conditional?

What is an example of metacognitive planning? Monitoring? Evaluating? Revising?

A. Metacognition as a learner

[Group Discussion – 15 minutes] Now that we've focused our attention on metacognition, let's explore our past experiences with it as learners. Take 5-7 minutes and answer the following three questions on a piece of paper:

i. What experiences have you had with metacognition as a student?
    1. Now as a life-long learner?
ii. How has metacognition shaped you as a learner?
iii. How did you acquire metacognition?

Group discussion over key takeaways from each question.

B. Meta as a Teacher

[Group Discussion – 15 minutes] Some of you have accumulated these practices and strategies from your teachers, parents, or peers, either implicitly or explicitly. How have these strategies as learners impacted you as a teacher?

Answer the following three questions on a piece of paper:

i. How your experiences with metacognition shaped you as a teacher?
ii. How does metacognition impact how you reflect and improve on a day to day basis?
iii. How do you recognize metacognition in your students?

Who will share their thoughts? (discuss key takeaways)

Now let's transition, what kinds of opportunities do you provide for your students to acquire some of the strategies you have highlighted? Solicit ideas.

There are multiple ways to help facilitate metacognition with students, including providing students with activities that require them to use metacognition without formal instruction on it (implicit), as well as providing formal instruction in how to use metacognitive strategies (explicit). For our discussions today, we will move forward with an emphasis on explicit instruction of metacognition.

C. Facilitating Meta with Students – Schraw (1998) highlights four ways to facilitate metacognition with students: promoting awareness, improving metacognitive knowledge, improve metacognitive regulation, and foster conducive environments. How People Learn agrees, citing teaching with a metacognitive approach includes a focus on sense-making, self-assessment, and reflection (National Research Council, 2000).

i. <u>Promote Awareness</u> <u>[110 minutes]</u>

1. Discuss Metacognitive Knowledge and Regulation with students
    a. Metacognition can be general in nature (transferable across domains) (Schraw, 1998), but there is also a need to teach metacognition incorporated into the subject matter.

[10 minutes] Example – some pedagogy is valuable across all domains of teaching, but sometimes a lessons calls for specific pedagogy to that particular subject. Metacognition can be similar. Metacognitive strategies can be both general and subject-specific. Imbedding them into our subjects may help students acquire them quicker.

What would be an example of subject-specific metacognition? Take 3 minutes to discuss with a partner.

[Read and Discuss – 30 minutes] Handouts as resources: Tanner (2012); *Ten Metacognitive Teaching Strategies* (https://ciel.viu.ca/teaching-learning-pedagogy/designing-your-course/how-learning-works/ten-metacognitive-teaching-strategies) [These articles are intended to give teacher-participants some introductory ideas for how to incorporate metacognition strategies into their courses.]

Divide group into teams of three and jigsaw to read and discuss the two articles: Take 10 minutes and read your article utilizing the INSERT strategy (underline new information you did not previously know, write a question mark next to something you are unclear about, and write an exclamation mark next to important info). Locate your number on the top of the page, form a team with others of the same number. Discuss your article, answering each other's questions.

Now, form teams with others of the same letter (top of your page). These folks have a different article than you, you have 5 minutes to give the Cliff Notes version of the article you read.

Let's come together. What were the main points of the Tanner article? How can we apply this information in our classes?

What were the main points of the Ten Meta Strategies paper? How can we apply it?

[Total time – 1 hour] Let's put this into practice. In groups of two or three, choose one of the two FNS modules uploaded to the Google Drive folder. Read through the module, select a day(s) where a subject-specific metacognitive activity can be written in. Work with your partner to create that activity and write it into the curriculum (using comments on the FNS curriculum file that is already uploaded to Google Drive). Take 30 minutes to do this. Discuss activity creation as a whole group.

2. Teachers should model metacognition
    a. example: Math prof may discuss cognition as they do a proof set, but they also need to discuss their metacognition (like describe thought process/monitoring as they work the problem)
    b. How we can make our own thinking visible (National Research Council, 2000)

One way to help with subject-specific metacognition is to model it. *How People Learn* (National Research Council, 2000) calls this making our thinking visible. What is an example in AgEd of making our thinking visible?

3. Allot time for group discussion and reflection

ii. <u>Improve metacognitive knowledge [Total Time – 60 minutes]</u>

1. SEM – strategy evaluation matrix (Schraw, 1998)
    a. A listing of several learning strategies, including details of how to use them, when to use them, and why to use them.
    b. Promotes declarative, procedural, and conditional knowledge

c. Students continuously add to it

[Total time – 45 – 60 minutes] Let's put the SEM into practice! Together we will create our own SEM on a Google Doc, where everyone will have access. Take 20 minutes and write down every strategy you can think of on a Google Doc– including how they work, when to use them, and why to use them. Focus specifically on which days of the FNS curriculum you could utilize said strategy. Now let's come together and discuss.

iii. Improve metacognitive regulation [Total Time – 60 minutes]

1. Regulatory Checklist (Schraw, 1998)

a. Includes planning, monitoring, evaluation

[Time – 1 hour] Put in practice! In the shared Google folder is an example of a regulatory checklist. If you were going to make one of these for your class, what would be on it? Work in groups of three and create your own regulatory checklist to use with the FNS modules. Put this on a Google Doc to be shared. Devise questions that align with the two FNS curriculum units you will be teaching. Take 30 minutes to do this. Now let's come together and discuss, what did you include on your regulatory checklist? What should go on the master checklist?

iv. Fostering conducive environments [45 minutes]

1. Growth Mindset

[25 minutes] Take the Growth Mindset quiz. Discuss results as a group, hitting on:

a. Mental ability is not a fixed asset (Dweck, 2008; Sousa, 2017)

b. Learning can be improved with effort – metacognition can help

c. Facilitate positive locust of control (attribute success to effort and strategy) (Schraw, 1998)

Handouts as resources: Price-Mitchell (2015) Take 5 minutes and read the Price-Mitchell article. How can we apply these elements in our classes to create a more conducive environment for metacognition? [This article is intended to provide teachers with more generalized ideas for promoting a conducive metacognitive environment.]

Take the MAI [10 minutes]

Wrap-up [Group Discussion – 10 minutes]

Take 1 minute and think about your greatest takeaway(s) from today.

What did you find to be the most interesting?

What are you skeptical about?

What are you most anxious to try?

Tweet it! Using the hashtags #metacognition and #TeachAg, tweet about the one thing you will definitely do with your students as a result of this experience.

Appendix D - Metacognitive Awareness Inventory and Participant Responses

Question	Cindy	Nina	Mike	Gabby	Tim	Andrea
1. I ask myself periodically if I am meeting my goals (M)	1	1	1	1	1	1
2. I consider several alternatives to a problem before I answer (M)	1	1	1	1	1	1
3. I try to use strategies that have worked in the past (PK)	1	1	1	1	1	1
4. I pace myself while learning in order to have enough time (P)	1	1	0	0	1	0
5. I understand my intellectual strengths and weaknesses (DK)	1	1	1	1	1	1
6. I think about what I really need to learn before I begin to ask (P)	1	0	1	0	1	0
7. I know how well I did once I finish a test (E)	1	0	1	1	0	1
8. I set specific goals before I begin a task (P)	1	1	1	1	1	1
9. I slow down when I encounter important information (IMS)	1	1	1	0	1	1
10. I know what kind of information is most important to learn (DK)	0	0	1	1	1	1
11. I ask myself if I have considered all options when solving a problem (M)	0	0	1	1	0	1
12. I am good at organizing information (DK)	1	1	1	1	0	1
13. I consciously focus my attention on important information (IMS)	0	0	1	0	0	1
14. I have a specific purpose for each strategy I use (PK)	0	0	1	0	1	1
15. I learn best when I know something about the topic (CK)	1	1	1	1	1	1
16. I know what the teacher expects me to learn (DK)	0	1	1	1	0	1
17. I am good at remembering information (DK)	0	0	1	1	1	1
18. I sue different learning strategies depending on the situation (CK)	0	1	1	1	1	1
19. I ask myself if there was an easier way to do things after I finish a task (E)	0	0	1	1	0	1
20. I have control over how well I learn (DK)	1	0	1	1	0	1

21. I periodically review to help me understand important relationships (M)	1	1	1	1	0	1
22. I ask myself questions about the material before I begin (P)	0	0	1	0	1	0
23. I think of several ways to solve a problem and choose the best one (P)	1	1	1	1	1	1
24. I summarize what I've learned after I finish (E)	1	1	1	0	1	0
25. I ask others for help when I don't understand something (DS)	1	1	1	0	1	0
26. I can motivate myself to learn when I need to (CK)	1	1	1	1	0	1
27. I am aware of what strategies I use when I study (PK)	1	0	1	1	1	1
28. I find myself analyzing the usefulness of strategies while I study (M)	0	0	1	0	1	0
29. I use my intellectual strengths to compensate for my weaknesses (CK)	1	1	1	1	1	1
30. I focus on the meaning and significance of new information (IMS)	1	1	1	0	1	1
31. I create my own examples to make information more meaningful (IMS)	1	1	1	1	1	1
32. I am a good judge of how well I understand something (DK)	1	1	1	1	0	1
33. I find myself using helpful learning strategies automatically (PK)	1	0	1	1	1	1
34. I find myself pausing regularly to check my comprehension (M)	0	1	1	0	1	1
35. I know when each strategy I use will be most effective (CK)	0	1	1	1	0	0
36. I ask myself how well I accomplished my goals once I'm finished (E)	1	1	1	1	0	0
37. I draw pictures or diagrams to help me understand while learning (IMS)	1	1	1	1	1	1
38. I ask myself if I have considered all options after I solve a problem (E)	0	0	1	1	0	1

39. I try to translate new information into my own words (IMS)	1	1	1	1	1	1
40. I change strategies when I fail to understand (DS)	0	1	1	1	0	1
41. I use the organizational structure of the text to help me learn (IMS)	0	1	1	1	0	1
42. I read instructions carefully before I begin a task (P)	0	1	1	0	0	1
43. I ask myself if what I'm reading is related to what I already know (IMS)	1	0	1	1	1	1
44. I reevaluate my assumptions when I get confused (DS)	1	1	1	1	0	0
45. I organize my time to best accomplish my goals (P)	1	1	0	0	0	0
46. I learn more when I am interested in the topic (DK)	1	1	1	1	1	1
47. I try to break studying down into smaller steps (IMS)	1	1	1	0	1	1
48. I focus on overall meaning rather than specifics (IMS)	0	1	1	1	0	0
49. I ask myself questions about how well I am doing while I am learning something new (M)	1	1	1	0	1	1
50. I ask myself if I learned as much as I could have once I finish a task (E)	0	0	0	0	1	0
51. I stop and go back over new information that is not clear (DS)	0	1	1	1	1	1
52. I stop and reread when I get confused (DS)	1	1	1	1	1	1

Note. Adapted from Schraw, G. & Dennison, R.S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19*, 460-475. DK, declarative knowledge; PK, procedural knowledge; CK, conditional knowledge; P, planning; IMS, information management strategies; M, monitoring; DS, debugging strategies; and E, evaluation (p. 474). A '1' indicates a yes response, and a '0' indicates a no response.

Appendix E - Interview Protocol

**Note.* Research questions applying to interview protocol questions are identified within parentheses following each respective protocol question.

Research Questions

1. How does knowledge of metacognitive strategies influence teacher perception of the learning process in a PBL instructional environment?
2. How do teachers facilitate student learning in a PBL instructional environment before and after metacognitive professional development?
3. What are educators' interpretations of student metacognitive regulation and knowledge during a PBL instructional environment?
4. How do teachers view their roles in influencing student metacognition?

Interview 1

**Note.* Parentheses indicates association with Research Questions

1.A. How does PBL impact the learning process for students? (Q1)

1.B. How has PBL impacted your perceptions of the learning process? (Q1)

1.C. During a PBL unit, what is the most important step in the learning process? (Q1/2)

   a. How does it compare with a more traditionally-taught unit?

1.D. How can you recognize a student who is struggling to learn in your class? (Q1/2)

1.E. In a typical class, describe what a successful student looks like. (Q1)

   a. What does a successful student look like in your PBL class?

1.F. In a typical class, when a student is struggling how do you help them better learn the material? (Q2)

   a. What about in your PBL class?

1.G. When planning for class, I focus most of my attention on: _____(Q2)

a. Why?

1.H. How do you assess student learning in PBL? (Q2)

a. What about in more traditional classes?

1.I. How do you believe you can impact students' thinking about the learning process, if at all? (Q1/2/3/4)

Interview 2

2.A. How do you feel about metacognition right now? (Q2/4)

2.B. Where do you think metacognition fits into the learning process? (Q1)

a. Into the PBL process?

2.C. How does awareness of metacognition change/not change your views of a successful student? (Q1)

2.D. How do feel metacognition could impact student mastery of content? (Q1)

a. How do feel PBL could impact student mastery of content?

2.E. How do you know if a student is struggling metacognitively? (Q1)

a. What do you do?

2.F. Describe a student who struggles with metacognitive knowledge. (Q1/3)

a. Prompt MK definition: Facet of knowledge related to knowing *about* yourself and the learning process, knowing *how* learning strategies work, and knowing *when* to use those strategies.

b. How do you think this hinders this student?

2.G. Describe a student who struggles with metacognitive regulation. (Q1/3)

a. Prompt MR definition: Component of metacognition used to regulate and oversee learning, may include panning, monitoring, evaluating, and/or revising.
b. How do you think this hinders this student?

2.H. Describe a student who is successful with metacognitive knowledge. (Q1/3)
a. How do you think this benefits this student?

2.I. Describe a student who successfully applies metacognitive regulation. (Q1/3)
a. How do you think this benefits this student?

2.J. Describe why it might be beneficial for educators to learn about metacognition. (Q1/2/3/4)

2.K. How do you believe you can impact a student's use of metacognition, if at all? (Q1/2/3/4)

Interview 3

3.A. How are you feeling about metacognition right now? (Q2/4)

3.B. How did you identify struggling students during the PBL units these past couple months? (Q2/3)

3.C. Over the past two months, how did you prepare for your pbl class? (Q1/2)

3.D. Where do you think metacognition fits into the learning process? (Q1/2/3/4)
a. Into the PBL process?

3.E. How does metacognition impact the learning process for students during PBL? (Q1/2/3/4)

3.F. How do you recognize a student utilizing metacognitive knowledge? (Q3)
a. What kinds of questions do they ask?

3.G. How do you recognize a student utilizing metacognitive regulation? (Q3)
a. What kinds of questions do they ask?

3.H. At what stages in a PBL unit do you feel students are most metacognitive? (Q3)

b. Most metacognitive knowledge?

c. Most metacognitive regulation?

3.I. Describe a student who struggles with metacognitive knowledge. (Q1/3)

d. Prompt MK definition: Facet of knowledge related to knowing *about* yourself and the learning process, knowing *how* learning strategies work, and knowing *when* to use those strategies.

e. How do you think this hinders this student?

f. How has the PBL unit impacted your perception of that student?

3.J. Describe a student who struggles with metacognitive regulation. (Q1/3)

g. Prompt MR definition: Component of metacognition used to regulate and oversee learning, may include panning, monitoring, evaluating, and/or revising.

h. How do you think this hinders this student?

3.K. Describe a student who is successful with metacognitive knowledge. (Q1/3)

i. How do you think this benefits this student?

3.L. Describe a student who successfully applies metacognitive regulation. (Q1/3)

j. How do you think this benefits this student?

3.M. Describe a time when you recognized a student identifying a knowledge deficit during a problem they encountered during PBL instruction. (Q3)

3.N. Describe a time when you recognized a student applying new knowledge to a problem they encountered during PBL instruction. (Q3)

3.O. What, if any, differences did you notice between students regarding their use of meta?

3.P. Describe why it might be beneficial for educators to learn about metacognition. (Q1/2/3/4)

3.Q. How do you believe you can impact a student's use of metacognition, if at all? (Q1/2/3/4)

3.R. Based on what you have experienced with PBL and metacognition, how will your practice with future instruction change? (Q4)

Appendix F - Metacognitive Prompts

Prompt 1

Unit 1 – *Food for Thought* from FNS Curriculum

Metacognitive prompt #1, after day 8 of unit – Now that we have learned about food groups, recommendations for healthy diets, and how to calculate calorie requirements, answer the following questions about your progress in this project:

a. What do you still need to learn about before you can complete this project and create your system to track eating? How do you know you need to learn that? (MK – declarative, MR – Evaluation)
b. What have you done to help yourself (or your group members) keep track of the things you have learned about so far related to diets and eating? Why did you do/not do those things? (MK – Procedural/Conditional)
c. If you could go back and adjust something either you learned about or submitted during this project, what would it be? Why would you change that? (MR – Monitoring/Evaluating/Revising)
d. How will you work with your team members to develop a food tracking system? How will you know what to include in the system? (MR – Planning)

Prompt 2

Unit 1 – *Food for Thought* from FNS Curriculum

Metacognitive prompt #2, after day 16 of unit – Now that we have explored tracking systems, developed our own tracking system, and pilot tested our system, answer the following questions about your progress in this project:

a. What did you learn in this project that will help you convey your system to audiences during your presentation next week? How do you know that learning will help you? (MK – declarative, MR – Evaluation)
b. Why was your system for tracking eating a success (or not)? What actions of you and your group contributed to that success/non-success? Why did you do/not do those things? (MK – Procedural/Conditional)
c. If you could go back and adjust something either you learned about or submitted during this project, what would it be? Why would you change that? (MR – Monitoring/Evaluating/Revising)
d. How will you work with your team members to develop your presentation? How will you know what to include in the presentation? (MR – Planning)

Prompt 3

Unit 2 – *Beef It's What's for Dinner* from FNS Curriculum

Engagement Scenario: After a recent outbreak of food-borne illness related to beef, develop a training protocol for local restaurants to use. Research food safety related to E. coli to develop these protocols.

Metacognitive prompt #3, after day 8 – Now that we have learned about pathogens, bacteria, and experiential growth, answer the following questions about your progress in this project:

a. What do you still need to learn about before you can complete this project and create your training program? How do you know you need to learn that? (MK – Declarative, MR - Evaluation)

b. What have you done to help yourself (or your group members) keep track of the things you have learned about so far related to Beef safety? Why did you do/not do those things? (MK – Procedural/Conditional)
c. If you could go back and adjust something either you learned about or submitted during this project, what would it be? Why would you change that? (MR – Monitoring/Evaluating/Revising)
d. How will you work with your team members to develop a food training program? How will you know what to include in the program? (MR – Planning)

Prompt 4

Unit 2 – *Beef It's What's for Dinner* from FNS Curriculum

Metacognitive prompt #4, after day 17 of unit – Now that we have explored and demonstrated safe food handling procedures such as FATTOM, and created a food handling training program to be used by a local restaurant, answer the following questions about your progress in this project:

a. What did you learn in this project that will help you "sell" your system to local restaurants during your presentation next week? How do you know that learning will help you? (MK – declarative, MR – Evaluation)
b. Why was your food handling program a success (or not)? What actions of you and your group contributed to that success/non-success? Why did you do/not do those things? (MK – Procedural/Conditional)
c. If you could go back and adjust something either you learned about or submitted during this project, what would it be? Why would you change that? (MR – Monitoring/Evaluating/Revising)

d. How will you work with your team members to deliver your presentation? How will you know what to include in the presentation? (MR – Planning)

Appendix G - PBL Fidelity Rubric

Element of PBL Apparent in Video	Not Apparent (0)	Apparent (1)
Students Engaged in Authentic Problem	No evidence in video that students are working to solve an authentic problem	Evidences in video that students are working to solve an authentic problem
Creation of Artifacts	No evidence in video of students creating artifacts or products outlined in the curriculum units	Evidences in video of students creating artifacts or products outlined in the curriculum units
Investigation by Students	No evidence in video of student-led investigation, or a presence of teacher-led activities (e.g., lecture)	Evidence in video of student-led investigation, or is devoid of teacher-led activities (e.g., lecture)
Community of Inquiry	No evidence of student-to-student or student-to-teacher collaboration	Evidence of student-to-student or student-to-teacher collaboration

Participant: _____

Video number _____

Total score: _____/4

Appendix H - PBL Fidelity Scoresheet for Cindy

Video Number – Minute number	Authentic Problem (0 or 1)	Artifact (0 or 1)	Student Investigation (0 or 1)	Community of Inquiry (0 or 1)	Total _/4
1 - 1	Discussing the Swivl with students				
1 – 6	0	0	1	1	2
1 – 11	1	1	1	1	4
1 – 16	1	1	1	1	4
1 – 21	1	1	1	1	4
1 – 26	1	1	1	1	4
1 – 31	1	1	1	1	4
1 – 36	1	1	1	1	4
1 – 41	1	1	1	1	4
8 – 1	Announcements				
8 – 6	1	1	1	1	4
8 – 11	1	1	1	1	4
8 – 16	1	1	1	1	4
8 – 21	1	1	1	1	4
8 – 26	1	1	0	1	3
8 – 31	1	1	0	1	3
8 – 36	1	1	1	1	4
8 – 41	1	1	1	1	4
8 – 46	Students packing up and leaving				
15 – 1	1	0	0	0	1
15 – 6	1	0	1	1	3
15 – 11	1	0	1	1	3
15 – 16	1	1	1	1	4
15 – 21	1	1	1	1	4
15 – 26	1	1	1	1	4
15 – 31	1	1	1	1	4
15 – 36	1	1	1	1	4
15 – 41	1	1	1	1	4
15 – 46	1	1	1	1	4
22 – 1	1	1	1	1	4
22 – 6	1	1	1	1	4
22 – 11	1	1	1	1	4
22 – 16	1	1	1	1	4
22 – 21	0	0	0	0	0
22 – 26	1	1	1	1	4
22 – 31	1	1	1	1	4
22 – 36	1	1	0	1	3
22 – 41	1	1	1	1	4
29 – 1	1	0	0	0	1
29 – 6	1	1	1	1	4

29 – 11	1	1	1	1	4
29 – 16	1	1	1	1	4
29 – 21	1	1	1	1	4
29 – 26	1	1	1	1	4
		Total	147	Mean	3.59

Note. A ‘0’ represents absence of PBL element and a ‘1’ represents presence of PBL element.

Appendix I - PBL Fidelity Scoresheet for Andrea

Video Number – Minute number	Authentic Problem (0 or 1)	Artifact (0 or 1)	Student Investigation (0 or 1)	Community of Inquiry (0 or 1)	Total _/4
1 – 1	1	1	1	1	4
1 – 6	1	1	0	1	3
1 – 11	1	1	1	0	4
1 – 16	1	1	1	1	4
1 – 21	1	1	1	1	4
1 – 26	1	1	1	1	4
1 – 31	1	1	1	0	3
1 – 36	1	1	1	1	4
1 – 41	1	1	1	1	4
1 – 46	1	1	1	1	4
7 – 1	1	1	0	1	3
7 – 6	1	1	1	1	4
7 – 11	1	1	1	1	4
7 – 16	1	1	1	1	4
7 – 21	1	1	1	1	4
7 – 26	1	1	0	1	3
7 – 31	1	1	0	1	3
7 – 36	1	1	1	1	4
7 – 41	1	1	1	1	4
13 – 1	1	1	1	1	4
13 – 6	1	1	1	1	4
13 – 11	1	1	1	0	3
13 – 16	1	1	1	0	3
13 – 21	1	1	1	1	4
13 – 26	1	1	1	1	3
13 – 31	1	1	1	1	4
13 – 36	1	1	1	0	3
19 – 1	1	1	1	1	4
19 – 6	1	1	1	0	3
19 – 11	1	1	0	1	3
19 – 16	1	1	1	1	4
19 – 21	1	1	0	1	3
25 – 1	1	1	0	0	2
25 – 6	1	1	0	1	3
25 – 11	1	1	1	1	4
25 – 16	1	1	1	1	4
25 – 21	1	1	1	1	4
25 – 26	1	1	1	1	4
25 – 31	1	1	1	0	3
25 – 36	1	1	0	1	3

	Total	143	Mean	3.58

Note. A ‘0’ represents absence of PBL element and a ‘1’ represents presence of PBL element.

Appendix J - PBL Fidelity Scoresheet for Mike

Video Number – Minute number	Authentic Problem (0 or 1)	Artifact (0 or 1)	Student Investigation (0 or 1)	Community of Inquiry (0 or 1)	Total _/4
1 - 1	1	1	1	0	3
1 – 6	1	1	0	0	2
1 – 11	1	1	1	1	4
3 – 1	1	0	1	1	3
5 – 1	1	0	0	1	2
5 – 6	1	1	0	1	3
7 – 1	1	0	0	1	2
9 – 1	Distributed notebooks				
9 – 6	1	0	1	1	3
9 – 11	1	1	1	1	4
9 – 16	1	1	1	1	4
9 – 21	1	0	1	1	3
9 – 26	1	0	1	1	3
9 – 31	1	0	0	0	1
		Total	37	Mean	2.85

Note. A ‘0’ represents absence of PBL element and a ‘1’ represents presence of PBL element.

Appendix K - PBL Fidelity Scoresheet for Tim

Video Number – Minute number	Authentic Problem (0 or 1)	Artifact (0 or 1)	Student Investigation (0 or 1)	Community of Inquiry (0 or 1)	Total _/4
1 - 1	1	0	0	1	2
1 – 6	1	0	0	1	2
1 – 11	1	0	0	1	2
1 – 16	1	0	0	1	2
1 – 21	1	0	0	1	2
1 – 26	1	0	0	1	2
1 – 31	1	0	0	1	2
3 – 1	1	0	0	1	2
3 – 6	1	1	1	1	4
3 – 11	1	1	0	1	3
5 – 1	1	1	1	1	4
7 – 1	1	1	0	1	3
7 – 6	1	1	1	1	4
9 – 1	1	1	1	1	4
		Total	38	Mean	2.71

Note. A ‘0’ represents absence of PBL element and a ‘1’ represents presence of PBL element.

Appendix L - Artifact Rubric

Elements of Metacognition in Student Artifact	Not Present (0)	Slightly Present (1)	Modestly Present or More (2)
MK – Declarative	Student makes no mention of knowledge about themselves as a learner, or about learning in general	Student may mention knowledge about themselves as a learner, or about learning in general, but reasoning is incomplete	Student provides insight into knowledge about themselves as a learner, or about learning in general
MK – Procedural	Student makes no mention of knowledge of how learning strategies work, or of how to chunk information	Student may mention knowledge of how learning strategies work, or of how to chunk information, but reasoning is incomplete	Student provides insight into knowledge of how learning strategies work, and of how to chunk information
MK – Conditional	Student makes no mention of when they used the strategy, or why they chose it	Student may mention when they used the strategy, or why they chose it, but reasoning is incomplete	Student provides insight into when they used the strategy, and why they chose it
MR – Planning	Student does not accurately describe the use of any planning strategies (goal-setting, strategy-selection, etc.)	Student may describe trace use of planning strategies (goal-setting, strategy-selection, etc.), descriptions may contain inaccuracies	Student accurately describes the use of planning strategies (goal-setting, strategy-selection, etc.) utilized before a learning opportunity
MR – Monitoring	Student does not accurately describe the use of any monitoring strategies (self-testing, tracking progress, etc.)	Student may describe trace use of monitoring strategies (self-testing, tracking progress, etc.), descriptions may contain inaccuracies	Student accurately describes the use of monitoring strategies (self-testing, tracking progress, etc.) utilized during a learning opportunity
MR – Evaluating	Student does not accurately describe the use of any evaluating strategies (self-evaluations, making self-judgments of work, etc.)	Student may describe trace use of evaluation strategies (self-evaluations, making self-judgments of work, etc.), descriptions may contain inaccuracies	Student accurately describes the use of evaluation strategies (self-evaluations, making self-judgments of work, etc.) utilized during/after a learning opportunity

MR – Revising	Student does not accurately describe the use of any revising strategies (setting time aside to make adjustments, etc.)	Student may describe trace use of revising strategies (setting time aside to make adjustments, etc.), descriptions may contain inaccuracies	Student accurately describes the use of revising strategies (setting time aside to make adjustments, etc.) utilized during/after/before a learning opportunity

MK – 6 total points possible

MR – 8 total points possible

Appendix M - Student Artifacts Scoresheet for Cindy

All writings were submitted in two independent documents. Student responses were scored in order (i.e., student number one is the first student response for that respective prompt on the document)

Table M.1

Unit: Food for Thought Prompt: 1

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	N/A No student writings submitted to the researcher								
		MK Mean =					MR Mean =		

Table M.2

Unit: Food for Thought Prompt: 2

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	N/A No student writings submitted to the researcher								
		MK Mean =					MR Mean =		

Table M.3

Unit: Beef, it's what's for Dinner Prompt: 3

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	0	1	0	1	1	1	0	1	3
2	1	1	1	3	1	1	1	1	4
3	2	1	1	4	1	2	2	2	7
4	1	1	1	3	1	1	1	1	4
5	1	1	0	2	0	1	1	1	3
6	Omitted – student answered wrong questions								
	MK Mean = 2.6				MR Mean = 4.20				

Table M.4

Unit: Beef, it's what's for Dinner Prompt: 4

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	1	0	0	1	1	1	1	1	4
2	1	0	0	1	0	1	1	1	3
3	2	0	0	2	1	2	1	1	5
4	2	0	0	2	2	2	1	2	7
5	1	0	0	1	0	0	1	0	1
6	1	0	0	1	0	1	1	0	2
7	1	0	0	1	0	1	1	2	4
	MK Mean = 1.29				MR Mean = 3.71				

Appendix N - Student Artifacts Scoresheet for Mike

All writings were submitted in PDFs. Student responses were scored in order (i.e., student number one is the first student response for that respective prompt on the PDF)

Table N.1

Unit: Food for Thought Prompt: 1

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	1	1	1	3	0	0	1	1	2
2	0	0	0	0	0	1	1	0	2
3	1	1	1	3	0	1	0	0	1
4	1	0	0	1	1	1	1	0	3
5	0	1	0	1	0	1	1	1	3
6	1	0	0	1	0	1	1	1	3
7	Omitted – student provided incomplete responses								
8	1	1	1	3	0	1	1	0	2
9	0	1	0	1	0	1	1	0	2
		MK Mean = 1.63					MR Mean = 2.25		

Table N.2

Unit: Food for Thought Prompt: 2

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	N/A No student writings submitted to researcher								
		MK Mean =					MR Mean =		

Table N.3

Unit: Beef, it's what's for Dinner Prompt: 3

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1*	1	1	0	2	2	1	1	1	5
2	0	0	0	0	1	1	0	0	2
3	1	1	1	3	0	1	1	1	3
4	1	1	0	2	1	1	1	0	3
5	1	1	0	2	1	1	1	1	4
		MK Mean = 1.80					MR Mean = 3.4		

*Note. Response was scanned into two PDFs – researcher scored the first response located with prompt 1 responses.

Table N.4

Unit: Beef, it's what's for Dinner Prompt: 4

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	1	0	0	1	0	1	1	1	3
2	0	0	0	0	0	1	0	1	2
3			Omitted – incomplete responses and page was not fully scanned						
4	1	0	0	1	0	1	1	1	3
5	1	0	0	1	0	1	2	1	4
6	1	0	0	1	0	1	1	0	2
7	1	0	0	1	0	1	1	1	3
8	1	0	0	1	0	1	0	1	2
9	0	0	0	0	0	1	0	1	2
10			Omitted – unclear if student answered questions						
		MK Mean = .75					MR Mean = 2.63		

Appendix O - Student Artifacts Scoresheet for Tim

Table O.1

Unit: Food for Thought Prompt: 1

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	2	1	1	4	1	1	1	1	4
2	0	1	1	2	1	1	1	0	3
3	2	0	0	2	1	0	1	0	2
4	1	1	0	2	0	1	1	1	3
5	1	1	1	3	0	1	1	0	2
6	1	0	0	1	0	1	1	0	2
7	1	1	1	3	0	1	0	0	1
8	1	0	0	1	1	2	2	1	6
9	1	1	1	3	0	1	0	0	1
		MK Mean = 2.33					MR Mean = 2.67		

Table O.2

Unit: Food for Thought Prompt: 2

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	1	0	0	1	1	0	1	1	3
2	1	0	0	1	0	2	1	0	3
3	1	0	0	1	0	1	1	0	2
4	2	0	0	2	2	1	1	0	4
5	2	2	2	6	1	1	2	1	5
6	1	0	0	1	0	1	1	0	2
7	1	0	0	1	1	0	1	0	2
		MK Mean = 1.71					MR Mean = 3.00		

Table O.3

Unit: Beef, it's what's for Dinner Prompt: 3

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	1	1	1	3	0	1	1	0	2
2	1	1	1	3	1	1	1	0	3
3	1	1	1	3	1	1	1	1	4
4	2	2	2	6	1	2	1	2	6
5	1	1	0	2	1	2	1	0	4
6	2	0	0	2	1	1	1	0	3
7	1	1	1	3	1	2	2	1	6
8	1	0	0	1	1	1	1	1	4
9	1	1	1	3	0	1	1	0	2
10	2	1	0	3	1	1	1	1	4
11	2	1	2	5	1	2	1	1	5
12	1	1	0	2	1	1	1	1	4
13	1	1	0	2	1	1	1	1	4
14	1	1	1	3	1	1	1	0	3
15	1	2	2	5	1	1	1	1	4
16	2	1	0	3	0	2	2	1	5
		MK Mean = 3.06					MR Mean = 3.93		

Table O.4

Unit: Beef, it's what's for Dinner Prompt: 4

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
			N/A No student writings submitted to researcher						
		MK Mean =					MR Mean =		

Appendix P - Student Artifacts Scoresheet for Andrea

All writings were submitted in PDF. Student responses were scored in order (i.e., student number one is the first student response for that respective prompt on the PDF)

Table P.1

Unit: Food for Thought Prompt: 1

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	1	1	1	3	1	2	1	0	4
2	1	1	1	3	1	1	1	0	3
3	1	1	1	3	1	1	1	0	3
4	1	1	1	3	0	1	1	1	3
5	1	1	1	3	0	1	1	1	3
6	Omitted – could not read responses								
7	1	0	0	1	0	1	1	1	3
8	1	1	0	2	1	1	1	1	4
	MK Mean = 2.57				MR Mean = 3.29				

Table P.2

Unit: Food for Thought Prompt: 2

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	0	1	0	1	0	1	1	1	3
2	0	0	0	0	1	1	1	0	3
3	0	0	0	0	1	1	1	1	4
4	2	0	0	2	1	1	1	2	5
5	1	1	0	2	1	1	2	2	6
6	0	0	0	0	0	1	1	1	3
7	0	0	0	0	0	1	1	0	2
8	0	0	0	0	0	1	1	1	3
		MK Mean = .63					MR Mean = 3.63		

Table P.3

Unit: Beef, it's what's for Dinner Prompt: 3

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	1	1	0	2	2	1	2	1	6
2	1	0	0	1	0	1	0	1	2
3	1	0	0	1	1	1	2	1	5
4	2	1	0	3	1	1	1	1	4
5	1	0	0	1	0	1	1	1	3
6	1	1	1	3	1	1	1	1	4
7	1	0	0	1	0	1	1	1	3
8	1	0	0	1	0	1	1	1	3
		MK Mean = 1.63					MR Mean = 3.75		

Table P.4

Unit: Beef, it's what's for Dinner Prompt: 4

Student Number	MK – Declarative	MK – Procedural	MK – Conditional	MK Total	MR – Planning	MR – Monitoring	MR – Evaluating	MR – Revising	MR Total
1	1	0	0	1	1	1	1	2	5
2	1	0	0	1	0	1	1	0	2
3	1	0	0	1	1	1	1	1	4
4	1	1	0	2	0	1	1	1	3
5	1	0	0	1	1	1	1	1	4
6	1	0	0	1	1	1	1	1	4
7	1	0	0	1	1	1	1	1	4
8	1	0	0	1	1	0	1	1	3
9	1	0	0	1	1	1	1	1	4
10	1	0	0	1	0	1	2	1	4
		MK Mean = 1.10					MR Mean = 3.70		

Appendix Q - Debriefing Statement

Dear_____,

Thank you for your participation in my study of metacognition during a Project-based Learning environment. I hope this study has been as beneficial for you as it has been for me. I would like to take a moment and debrief you about my research. The information discovered while conducting these interviews will help formulate suggestions of how teacher education programs can be improved in order to help young teachers be more prepared to use expert pedagogical techniques in fostering metacognition.

Your insights into your instructional strategies have helped me gain an understanding of how you understand metacognition, and how you perceive it within your students' thinking and actions. These understandings of metacognition will enable teacher-educators to make informed decisions of curriculum changes that could benefit teacher education programs. Metacognition has been shown to be a powerful element in the learning process of students, and hopefully this study provided insights for you concerning its use. This research will provide valuable comprehension of how we as educators can sustain or improve metacognitive strategies.

Thank you for your participation,

R. Bud McKendree

Appendix R - Letter to Expert Review Panel

Dear Dr._____,

Thank you for agreeing to review my professional development modules focused on increasing metacognitive awareness of high school teachers. I look forward to your feedback! To ensure I have time to lead the teachers through these material before their next school year begins, I kindly request you provide me with your feedback by June 22nd. To help with the review process I have included some additional information below, including my research purpose and questions, a description of my participants, an operational definition of "metacognitively aware," as well as some questions to guide you through the review process.

Purpose

This study seeks to explore how educators facilitate learning and perceive metacognition in a Project-based Learning (PBL) instructional environment after participating in professional development on metacognitive strategies, and includes the following questions:

1. How does knowledge of metacognitive strategies influence teacher perception of the learning process in a PBL instructional environment?
2. How do metacognitively aware educators facilitate student learning in a PBL instructional environment?
3. What are educators' interpretations of student metacognitive regulation and knowledge during PBL instruction?
4. How do teachers view their roles in influencing student metacognition?

Participants

Teacher-participants are current high school educators in the state of Kansas. They teach a variety of courses in mostly rural school districts, including such courses as introduction to

agriculture, animal science, biology, food science, plant science, environmental science, and agricultural mechanics (welding, electricity, and woodworking). Most of these teachers will have four to six different "preps" – meaning they will teach a combination of four to six different classes throughout the day.

Metacognitively aware

A teacher who – borrowing elements of Reeve and Brown's (1985) definition – understands not only how to monitor and manipulate their own cognitive processes, but also understands how such monitoring and manipulation can be applied to students' cognitive processes. A metacognitively aware teacher knows the terms and strategies related to metacognition, and uses them during instruction with students to help increase student awareness of metacognitive processes.

Questions and areas to focus on during the review:

1. Do the online modules adequately prepare teachers with an understanding of metacognition and its crucial terms/words? If not, how can I improve it?
2. Does the in-person professional development provide teachers with strategies for facilitating metacognition within their students? If not, how can I improve it?
3. Which element of the modules and professional development would you consider to be the weakest?

Thank you again for your willingness to help me grow professionally and finish my dissertation. I look forward to hearing from you!

Buddy

Appendix S - Informed Consent Letter

IRB Informed Consent Template Form Page 2

PROJECT TITLE:

Teacher Perceptions of Student Metacognition in Project-Based Learning Contexts Before and After Professional Development 2018
Shannon Washburn

PROJECT APPROVAL DATE: **PROJECT EXPIRATION DATE:** 2019 **LENGTH OF STUDY:** 9 mos

PRINCIPAL INVESTIGATOR:

CO-INVESTIGATOR(S):

R. Bud McKendree

CONTACT DETAILS FOR PROBLEMS/QUESTIONS: Buddy's cell: 334-403-3777; email:rmckendree@ksu.edu
Shannon's office: 785-532-6151; email: sgw@ksu.edu

IRB CHAIR CONTACT NFORMATION: Rick Scheidt, Committee Chair
(785) 532-1483
rscheidt@ksu.edu

PROJECT SPONSOR: None

PURPOSE OF THE RESEARCH:

This study seeks to explore how educators facilitate learning and perceive student metacognition in a Project-Based Learning instructional environment after participating in professional development on metacognitive strategies.

PROCEDURES OR METHODS TO BE USED:

Professional development focused on metacognitive awareness as a treatment for participants. In addition, there will be three, 45 minute interviews via Zoom software to collect verbal data, and iPad Swivels will be used to collect video recordings of class.

ALTERNATIVE PROCEDURES OR TREATMENTS, IF ANY, THAT MIGHT BE ADVANTAGEOUS TO SUBJECT:

RISKS OR DISCOMFORTS ANTICIPATED:

No risks or discomforts anticipated.

BENEFITS ANTICIPATED:

Benefits include a one-time stipend of $200 for each teacher-participant. Other benefits may include a greater understanding of metacogntion, which may improve effectiveness as an educator.

EXTENT OF CONFIDENTIALITY:

Interview audio data and video recordings of class will be stored in a password-protected computer inside of a locked office.

IS COMPENSATION OR MEDICAL TREATMENT AVAILABLE IF INJURY OCCURS? ☐ Yes ☐ No

PARENTAL APPROVAL FOR MINORS:

PARENT/GUARDIAN APPROVAL SIGNATURE: **Date:**

Terms of participation: I understand this project is research, and that my participation is voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

(Remember that it is a requirement for the P.I. to maintain a signed and dated copy of the same consent form signed and kept by the participant).

PARTICIPANT NAME:			
PARTICIPANT SIGNATURE:		Date:	
WITNESS TO SIGNATURE: (PROJECT STAFF)		Date:	

Appendix T - Waiver for Use of Video in Classroom

My name is Buddy McKendree. I am working with your student's agricultural education teacher (Ms./Mrs./Mr.) on a research project as part of my doctoral research at Kansas State University. As part of the project, I am asking your consent to video record parts of (Ms./Mrs./Mr.) class. The research project focuses on the use and facilitation of metacognition in the classroom by teachers. As part of the project I have asked the six participating teachers to record their class each day during two, month-long units of instruction, taking place primarily in late August through October. The purpose of these recordings is solely to ensure my six participants teach in alignment with the curriculum they would normally teach.

Why I need the Videos for my Project

The videos serve as a way for me to verify for this research that my participants taught the curriculum they proclaimed to teach. The videos do not in any way serve as an evaluation of (Ms./Mrs./Mr.), or of your student. At the conclusion of my project I will watch several five-minute clips of each participant teaching to provide evidence I know they taught their curriculum with fidelity. The KSU Institutional Review Board has approved this research involving human subjects.

What the Videos Mean for You or Your Student

The video will not be used as any form of evaluation for your student, and (Ms./Mrs./Mr.) will strive to set the camera up strategically so that it records as little of student faces as possible. Once the videos are made, they will be stored in a password-protected educational-based Cloud company called *Swivl*, where only (Ms./Mrs./Mr.) and I will have access. When I watch the clips of the videos I will only be checking to ensure (Ms./Mrs./Mr.) followed her curriculum, and will

not make notes of individual students. No portions of the video will be shared as part of any publication from the research.

Please do not hesitate to contact me at my information below for questions:

Buddy McKendree

Phone: 334-403-3777

Email: rmckendree@ksu.edu

Signing below constitutes your consent for your student to participate in a classroom where video recording will occur as part of this project. It also acknowledges your understanding the video will only be accessible and viewed by the researcher (Buddy McKendree) and your student's teacher (Ms./Mrs./Mr.).

Student Name (printed): _____ Date: _____

Parent/Guardian Name (printed): _____

Parent/Guardian Name (Signed): _____