Metacognition and Teacher Beliefs

Abstract

Metacognition is an important component of the learning process for students and teachers. With disparate findings regarding teacher attention to student thinking, and other indications that teachers enter the profession with preconceived notions, we use semi-structured interviews and a researcher-created professional development experience on metacognition to explore how metacognition influences educators' perceptions of the learning process and their beliefs about teaching and learning. First, we present themes corresponding to each of the two research questions, with themes substantiated by participant quotes. Next, we present conclusions, including reflecting on how professional development offerings for secondary school teachers have the potential to challenge currently held paradigms by prospective participants. Additionally, we discuss the value of metacognition within the profession.

Keywords: metacognition; teacher beliefs; student thinking; project-based learning

Introduction

Plato once said, "when the mind is thinking it is talking to itself" ("Thinking about Thinking," n.d.). While education places a tremendous amount of importance on thinking deeply about subject matter, do we attend to the executive functions of the student brain (i.e., metacognition)? Current understanding of teacher facilitation of metacognition would suggest not, as teacher confidence in their knowledge of, and implementation of, metacognition may be overstated (Spruce & Bol, 2015). Given the importance of metacognition in the learning process (An & Cao, 2014; Burton, 2012; Gourgey, 1998; Pate & Miller, 2011; Wang et al., 1990), how metacognition influences teacher beliefs about the learning process is a topic that warrants further study.

Metacognition and Learning

A simple definition for metacognition was proposed by Hughes (2017) as recognizing and regulating one's thinking. 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 a key cog in student learning (Wang et al., 1990). 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 and posited its importance during the learning of a new skill and problem solving, respectively. Similarly, metacognition has also been linked to systems thinking with secondary Ag, Food, and Natural Resources Education (AFNRE) students (McKim & McKendree, 2020). Further, metacognition is a skill that can be explicitly taught to students and teachers (An & Cao, 2014; Thomas & Anderson, 2014; Zohar & David, 2008). However, despite its importance and teachability, it is a concept not currently widely understood and taught by educators (Hughes, 2017; McKendree & Washburn, 2017; Seraphin et al., 2012), and does require teachers to focus on an otherwise unobservable skill (i.e., internal) (National Research Council, 2000).

Teachers and Student Thinking

While an advanced focus for teachers on internal actions like students considering their own thinking may be a desirable outcome, prior research on teachers and their propensity to attend to non-metacognitive student thinking is inconclusive. On one hand, Levin et al. (2009) ascertained early career teachers have more ability to attend to student thinking than often given credit for, and thus teacher education programs should encourage that skill early on in programs. Somewhat conversely, Robinson et al. (2013) purported pre-service teachers became more teacher-centered in their depictions of teaching over the latter half of a teacher education course. While the evidence may seem to point in opposite directions, a common theme may be teachers need instruction in how to attend, analyze, and respond to student thinking (Barnhart & van Es, 2015). Specifically, it is difficult for educators to focus on how students are processing and reasoning, as opposed to simply focusing on accuracy of those thoughts (Barnhart & van Es, 2015). While metacognition differs from thinking deeply about content in that it is an executive function focused on thinking about one's own thinking (Flavell, 1979), it is a process of the mind and internal in nature – and thus not easily perceived by teachers (National Research Council, 2000).

Influences on Teacher Beliefs

While there may be a need for teachers to focus more on student thought, it presents as a challenge since teachers enter teacher education programs with preconceived notions about what good teaching may resemble (Robinson et al., 2013) – potentially interfering with their ability to adjust practices and become more student thinking-focused. Further complicating the matter, at times pre-service teachers have disparities between their beliefs and practice (Roberts et al, 2016), claiming certain characteristics of teaching as part of their epistemology but then describing operationalization differently. When advancing toward taking steps to adjust teacher beliefs, other research has differentiated how professional development (PD) may have varying levels of impact on teacher beliefs. In particular, PD focused on subject matter poses less of a challenge to teachers' interpretations of teaching and learning than more complex, abstract concepts (Hoekstra et al., 2009). Considering teachers may enter PD focused on metacognition with a limited understanding (Zohar & Barzilai, 2013), an important next step is the exploration of how metacognition-focused PD can impact teacher beliefs.

Statement of the Problem

Metacognition has been situated as important in the learning process and is considered to be a teachable skill. However, there exists mixed results in teachers' proclivity to attend to student thought, broadly defined (Barnhart & van Es, 2015; Levin et al., 2009; Robinson et al., 2013). With further discrepancies regarding the alignment of teacher beliefs and practices (Roberts et al., 2016), and educators entering with pre-conceived notions of good teaching (Robinson et al., 2013), more research is needed to explore how metacognition influences educators' perceptions of the learning process and their beliefs about teaching and learning. This study is part of a larger research project exploring teachers, metacognition, and the learning process, situated within a project-based learning (PBL) instructional environment with a professional development on metacognitive strategies. This paper will address the following 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 view their roles in influencing student metacognition?

Conceptual Framework

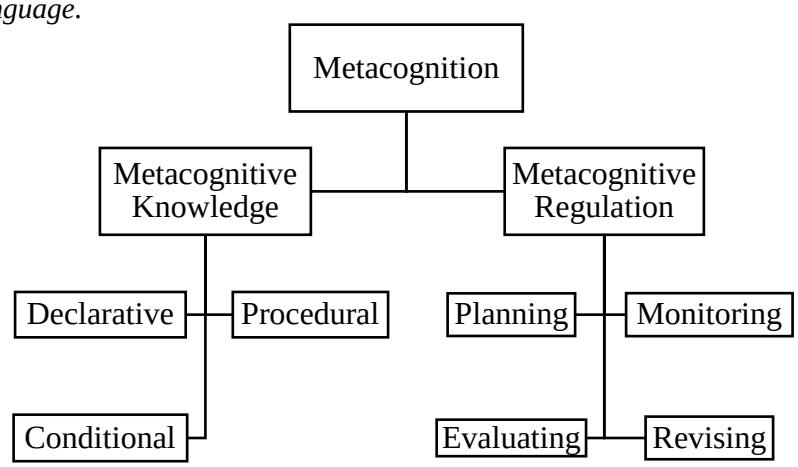
The framework for this study draws upon two concepts: (a) metacognition and (b) project-based learning.

Metacognition

Metacognition involves thinking about thinking (Flavell, 1979), or stated differently, a person's "ability to understand and manipulate their own" (p. 343) thinking (Reeve & Brown, 1985), and is generally understood to have two main components: a knowledge component and a regulation component (Brown et al., 1983; Jacobs & Paris, 1987; Schraw, 1998). Declarative knowledge, being what one knows about oneself as a learner as well as their general knowledge of the learning process, includes declarative, procedural, and conditional knowledge (Jacobs & Paris, 1987), while metacognitive regulation includes regulatory processes such as planning, monitoring, evaluating, and revising (Brown et al., 1983). A model of metacognition (An & Cao, 2014) adapted to the metacognitive knowledge language of Jacobs and Paris (1987) is shown in Figure 1:

Figure 1

Model of Metacognition (An & Cao, 2014) adapted with Jacobs and Paris' (1987) Metacognitive Knowledge language.



Project-Based Learning

Inquiry-based learning approaches to instruction, such as project-based learning (PBL), have been suggested to enhance student self-directed learning (SDL) skills (Blumberg, 2000; Hmelo & Lin, 2000; Loyens et al., 2008) and be beneficial in motivating and increasing the thoughtfulness of students (Barron et al., 1998; Blumenfeld et al., 1991; Krajcik et al., 1998). Thus, research (Blumberg, 2000; Davis, 2003; Downing et al., 2009; Gordon et al., 2001; Hmelo-Silver, 2004; Hmelo & Lin, 2000; Schraw et al. 2006; Sungur & Tekkaya, 2006;) exists supporting the inclusion of PBL as the backdrop for this study.

Specifically, PBL centers on a problem statement that is authentic to learners and provides structure to student learning (Thomas, 2000). Project-based learning includes four key features relevant to the present topic under investigation: students solving authentic problems, the problem statement leads students toward the creation of artifacts or products, the problem statement allows for investigation by students, and the instruction cultivates a community of inquiry (Krajcik et al., 1994).

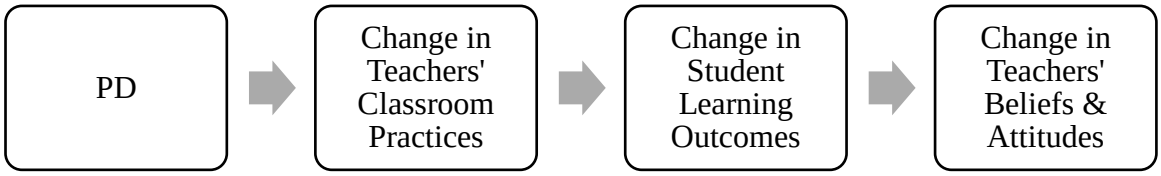
Theoretical Background

Model of Teacher Change

The theoretical background used to frame our study was Guskey's (1986) Model of Teacher Change (MTC). Exploring teacher change, Guskey proposed four things are needed: (a) professional development (PD); (b) change in classroom practice by the teacher; (c) change in student learning outcomes recognized by the teacher; and (d) a change in teacher beliefs and attitudes. Later, Guskey (2002) postulated changes in teacher attitudes and beliefs are focused more on student outcomes (as opposed to teachers themselves). In Guskey's model, a teacher must see a positive difference in student learning outcomes before said teacher will have a change in attitudes and beliefs. A model of teacher change is presented in Figure 2:

Figure 2

Model of Teacher Change adapted from Guskey (2002)



Our study used the MTC as a frame to explore teacher experiences as they moved through metacognitive PD and facilitation opportunities with students. Given metacognition's prominent standing in academic achievement of students, the current study could provide valuable insight into how metacognition influences teacher beliefs and attitudes toward the learning process.

Methods

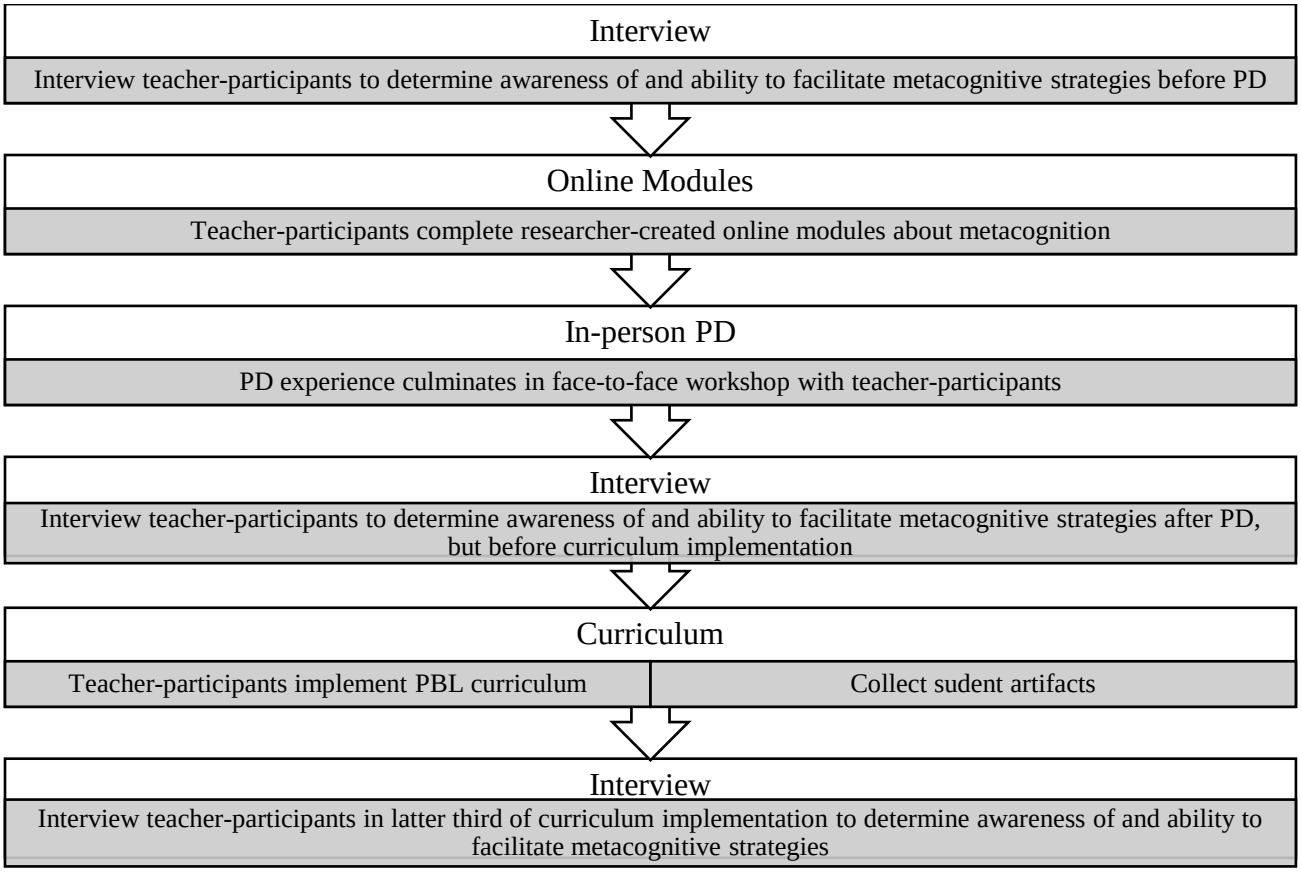
Overview

The research team utilized an in-depth, semi-structured, three-interview series following the Seidman technique (Seidman, 2013) with an interpretivist lens 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. An interpretivist lens allowed the researcher to understand participants' meaning making "as mediated through the researcher as instrument" (Merriam, 2002, p. 6).

Six participants were included in the study allowing for data saturation and increasing trustworthiness of findings. The lead researcher developed and facilitated a metacognitive professional development, and teacher-participants were then asked to implement two, four-week units of PBL curriculum. In alignment with Kansas State University's IRB protocols participants provided informed consent before completing the PD or interviews. See Figure 3 for a step-by-step outline of the study.

Figure 3

Research Design



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: (a) an online set of modules, and (b) an in-person training. The online element was made available to teacher-participants via the Kansas State University Canvas system after the first round of interviews. The three online modules were created with consistency in mind, with each including a researcher-narrated lecture and voluntary discussion questions. In addition, modules one and two included relevant readings. The three modules were informed by Brown et al. (1983) and Jacobs and Paris (1987) components of metacognition: metacognitive knowledge (module 1) and metacognitive regulation (module 2). The third and final module focused on the "so what?" of metacognition and its relation to student learning.

The in-person PD concentrated on evaluating current teaching practices and deciphering opportunities for facilitating metacognition with students. For the facilitation component of the PD, the lead researcher followed Schraw's (1998) proposed focal areas: (a) increasing student awareness of metacognition; (b) strategies targeting student metacognitive knowledge; (c) strategies targeting student metacognitive regulation; (d) and creating environments conducive to metacognition. Each

focal area included a reading and discussion followed by application opportunities for teacher-participants.

Participants

Participants included in the study were selected from a group of educators who had previously completed a comprehensive professional development in PBL and food science (i.e., Food and Nutrition Sciences [FNS] Institute). Selection criteria were minimal, as selected educators had to have completed at least one FNS Institute professional development, had to be willing to complete online and in-person metacognitive professional development, and had to be willing to teach two units of FNS food science curriculum with fidelity. Nine educators were initially included within the study, with six completing all three rounds of interviews. Table 1 shows the demographic breakdown of the teacher-participants for this study. To protect teacher-participants' confidentiality, names displayed are pseudonyms.

Table 1

Participant Demographic Breakdown

Participant	Teaching Field	Number of FNS Institutes Attended	Years of Experience in Teaching
Andrea	SBAE	2	6
Cindy	SBAE	3	8
Gabby	SBAE	2	17
Mike	SBAE	1	25
Nina	FACS	1	25
Tim	SBAE	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.

Data Collection

The lead researcher conducted semi-structured interviews 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. As part of a larger study, interview protocols addressed the following with teacher participants: (a) beliefs about the learning process before and after PD; (b) feelings toward metacognition and students; (c) perceptions of students' ability to utilize metacognition; (d) perceptions of facilitating metacognition; and (e) perceptions metacognition benefits for students.

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. According to Seidman, 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. 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.

Quality of research was strengthened by following Tracy's eight suggestions for excellent qualitative research, including selecting a worthy topic, building rigor, researcher sincerity, credibility, resonance, significant contribution, ethical, and meaningful coherence (Tracy, 2010). Examining some specific actions taken, trustworthiness was enhanced by member checking, peer debriefing, audit trails, and the inclusion of thick descriptions (Flick, 2009). Member checking can increase credibility and confirmability (Flick, 2009; Tracy, 2010) and was done by the lead researcher providing participants with the completed transcribed text, allowing them to review for accuracy and representativeness of thought. In addition, peer debriefs were conducted with a second research team member, reviewing and discussing themes, categories, codes, and notes periodically to cross-check analyses, thus increasing the dependability of the research (Flick, 2009). By providing thick descriptions of the context of the research, transferability is enhanced and thus making possible the "judgements about fittingness with other contexts" (Guba, 1981, p. 86).

Subjectivity

To increase trustworthiness and sincerity of the study, I (lead researcher) examined my own experiences related to teacher-participants, student thinking, and metacognition. My relationship with the teachers who participated in this study was strong, and I entered and left the project with a great deal of respect for their prowess as educators. I trusted they had students' best interests at heart and as practitioners continue to pursue more knowledge in areas of their instruction where they perceive a need. Based on this reflection, I approached teacher-participants in this study with a positive working relationship and relied on audit trails and peer debriefing throughout the study to ensure credibility of findings.

Data Analysis

Data were analyzed by the lead researcher using the constant comparative method (Glaser, 1965). 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 has four stages, moving from comparing incidents and categories to combining categories and their properties, then to determine the boundaries of the theory, before finally writing the theory (Glaser, 1965). The constant comparative method has become popular in qualitative research even though it may not result in theory development (Merriam 2002).

Following Flick's (2009) suggestion that coding reflects the researcher's style and stage of the research, for this study the lead researcher followed the constant comparative process that started by comparing individual quotes until categories and properties began to emerge. The lead researcher recorded notes throughout the process and peer debriefs to review emerging codes, categories, and themes were completed with other research team members. Due to the natural break in data (i.e., 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.

Findings

Findings for this study emanate from a larger research project. Thematic discoveries from both rounds of analysis are detailed in Table 2 and Table 3.

Table 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

Table 3

Themes, Categories, and Codes from Second and Third Rounds of Interviews

Theme	Category	Code
Metacognitive Feelings	Teacher attitudes toward metacognition	Enables more learning
		Helps become better learner
		Helps inform teachers why students succeed

Table Continued

		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
Teacher Expectations	For students	Success
		Student laziness
		Student doing metacognition
	For teachers	Teacher as responsible
		Attempt to be clear

We will focus on themes germane to the two stated research questions for this paper: (a) themes relevant to question one, which include beliefs on teaching, PBL benefits, metacognitive feelings, and teacher expectations; and (b) themes relevant to question two, which include beliefs on teaching, metacognitive feelings, and teacher expectations.

RQ 1 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 findings and 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." Included within these ideas was the need for teachers to drive engagement and take on the onus of learning, as Gabby describes helping students in a PBL setting,

> 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…

Similarly, Andrea described taking on the onus of learning by identifying where students' gaps in knowledge are, "and then go back and try to figure out where the holes of information are, so we can fill those in."

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 requiring, 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." Gabby offered a similar idea, discussing how metacognition can help students become problem solvers, "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?" Venturing further, teacher-participants offered thoughts about metacognition and self-efficacious students going hand-in-hand, as Nina suggested students successful with metacognitive knowledge will "definitely" have higher self-esteem and Tim described a metacognitive learner as one who can 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.

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." Cindy even mentioned she had not previously considered that metacognitive knowledge 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." Congruently, Gabby postulated she had actually 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, so they feel more successful in their own learning process." 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."

Aligning with a change in how success is viewed, 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 with organizing information, "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?"

Additionally, metacognition was deemed valuable, as many referenced wanting to learn more, and all suggested they will continue it. 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." Thus, 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.

RQ 2 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." Nina offered a similar thought, "[a student that struggles with metacognitive regulation is] going to take…longer to get to that depth of understanding." Gabby noted metacognition is important for student success in other subjects besides her own, "and the reason we're doing [metacognition] 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." However, their experiences of influencing metacognition within students potentially illuminates a new need – additional opportunities to confront negative transfer related to their existing paradigms about learning. It seems teacher-participants connected well enough to see value, but not well enough to differentiate the more subtle aspects of metacognition and how the teacher can influence them (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."

Potentially, self-efficacy was a limiting factor for some teacher-participants, preventing them from going "all-in" with their role in 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. Gabby offered a feeling of downward-trending confidence, as 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.

Also holding them back, a couple of participants hinted at feeling inauthentic while trying to facilitate metacognition, as Nina described feeling nervous about being able to make metacognitive facilitation "flow," and wondered if she could "be natural when…talking to students;" and Mike saying he "did not feel natural."

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. Tim offered an emblematic thought, "Oh, yeah, I mean, I think a lot of it depends on the, the individual's assertiveness, I think a lot of it dependent on their character, I think a lot of it on their enthusiasm to be knowledgeable, too." 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.

Conclusions

We present conclusions based on two ideas: (1) conceptualizing metacognition challenged existing teacher paradigms about the learning process; and (2) teacher-participants' saw value in metacognition and its contributions to student learning.

Metacognition and Challenging Existing Paradigms

Metacognition appears to be a complex topic that 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.

The idea of challenging paradigms and their impact on teacher change is parallel with what Hoekstra et al. (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. What happens when teachers participating in PD 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. A conclusion from this study is the need for metacognitive PDs to deliberately incorporate discussion on how metacognition fits, and does not fit, within PD participants' current paradigms. In the present study, teachers were apt to fit metacognition into existing paradigms of what a successful student was, focusing on desire to learn instead of underlying executive functions that may inhibit students' ability or efficiency as a learner. Challenging these paradigms or working with teachers to identify positive transfer of beliefs between the two ideas, is an important step toward further enhancing teacher understanding and development of metacognition in students. Further aligning with Hoekstra et al. (2009), one possible implication for all PD events targeted for secondary school educators is to re-consider how the focus of the PD can merge with existing beliefs held by prospective participants and build in deliberate discussions focused on those potentially conflicting beliefs about teaching and learning.

Recommendations for practice and research also emanate from the perceived complexity of metacognition and how teacher-participant's fit it within their existing paradigms. When facilitating learning events for teachers, organizers should consider teacher beliefs on learning as a major influencer on adoption of new beliefs or practices. Specifically, organizers should consider teacher beliefs of student ability and be explicit in discussing those beliefs with participants. Additionally, teacher education programs should consider the inclusion, or revisiting, of teaching and learning belief systems their preservice teachers hold about student ability. Are our preservice teachers leaving our programs with a deficit view of learning?

Future research could explore variables that may affect teacher understanding of metacognition, such as PD structure and teacher prior knowledge, among others. Future research could also explore which previously held teacher beliefs are the most challenging to educators who are attempting to learn about and facilitate metacognition. Shifting focus, research could also explore metacognitive usage by secondary and 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.

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. Teachers suggested positive changes in how they viewed student learning even if preexisting beliefs interfered with conceptualizing metacognition. These positive changes suggest further teacher learning in metacognition is valuable and can change teacher beliefs about learning. Potentially, it underscores that learning associated with metacognition can be enhanced with more time focused on intricacies and transference of knowledge and less time focused on utility of metacognition. 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.

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 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.

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