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Moving Forward to Creating Supports for PBI Mentors and Mentees

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Abstract: *Preservice teachers engage in clinical experiences with in-service teacher mentors to observe and apply theories being learned in coursework in classroom settings. Among the obstacles with clinical experiences is that mentor teachers may lack knowledge of theories being practiced by preservice teachers and may struggle to provide mentorship supports. This convergent mixed-method study engaged four undergraduate student researchers in exploring how a clinical-based course supports the development of the preservice teacher and how professional learning and mentoring experience support the development of the in-service mentor teacher. Findings indicate increases in knowledge and applications of PBI for preservice teachers and mentor teachers and increases in confidence from the in-service teachers to serve as mentors.*

Keywords: Project Based Instruction, Mentoring, Professional Development, Convergent Mixed Methods Research

Contributions of the undergraduate researchers

Undergraduate students engaged as members of the research team in this grant funded mixed method research study. Undergraduate student researchers developed survey and interview protocols, facilitated individual participant interviews, cleaned and analyzed qualitative research outcomes, ran statistical analysis of pre and post survey data, and reported study findings to the funding source both in a presentation setting and in written work.

LITERATURE REVIEW

Undergraduate preservice STEM teachers (PSTs) enrolled in the Project-based Instruction (PBI) course are required to complete a clinical experience with an in-service mentor teacher (MT). The clinical experience consists of classroom observations, project-based unit plan development, and a week-long teaching experience. These experiences give PST's opportunities to observe and apply PBI in real classroom contexts. The mentor-mentee relationship is crucial to the success of student teaching practicums and has the potential to enhance PST's experiences in the field, improve instructional practices, and increase commitment and retention in the profession (Feiman-Nemser et al., 1999; Ingersoll & Perda, 2010). Other studies have shown that professional learning and incorporating reflection in mentoring can improve coaching practices among MT's and, in

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turn, improve the PST's effectiveness in clinical practice (Lopez-Real & Kwan, 2005, Ronfeldt, 2021).

Among the obstacles with these clinical experiences is that MT's are inconsistent in their knowledge and practice of PBI. Research suggests that strong teachers do not always make strong mentors, however it has been shown that mentoring skills can be learned and developed over time (Ambrosetti, 2014). Professional learning for the MT's supporting PST's in PBI may support MT understanding of the course and the expectations of the clinical experiences to better situate the mentor teachers to provide quality mentorship. Previous studies have shown that developing MT's may have a positive impact on mentoring practices and development of PST's (Abrosetti, 2014; Riveros et al., 2012; Trevethan & Sandretto, 2017).

In our study we investigated MTs and PSTs working within a community of practice (Lave and Wenger, 1991). Within a mentoring community of practice social engagement is essential (Wenger, 1998) and the MT and PST are contributing knowledge and experience and are learning from each other in this process. Trevethen and Sandretto (2017) discuss this in terms of educative mentoring which includes specified roles for the MT and PST. Within an educative mentoring community of practice the MT provides collaboration and allows for the PST to try out new ideas while practicing their identity as a teacher. As a MT, they share their thinking and challenge the PST to also examine their own thinking. Integral to educative mentoring is the idea that both MT's and PSTs are active participants and learners. We use the concepts of educative mentoring within a community of practice to because it provides a lens with which to explore MT's and PST's knowledge, beliefs, and experiences to develop professionally in general and to develop skills with implementation of PBI.

DESIGN AND METHODOLOGY

This research study engaged four undergraduate students in a convergent mixed-methods study exploring research questions focused on development of MT's and PST's PBI knowledge and pedagogy and role of the mentor-mentee relationship during a semester-long experience.

DESIGN

A convergent design allows quantitative and qualitative results to be taken separately and the databases merged. The quantitative is used to display trends and relationships, whereas the qualitative gives a personal perspective and a more complete understanding of the data from the quantitative analysis (Creswell & Plano Clark, 2011). The research questions for the study were:

1. How do our qualitative data with MT's and PST's contribute towards our understanding of the quantitative differences in development of PBI knowledge and pedagogy?
2. How do qualitative data with MT's and PST's contribute to a more comprehensive and nuanced understanding of the quantitative differences pertaining to the mentor-mentee relationship?

METHODOLOGY

PARTICIPANTS

The study involved six MTs and 25 PSTs. Each MT had over 10 years of teaching experience over a wide range of content areas. The MTs had at least one PST that observed and taught a weeklong PBI unit in their classroom. PSTs are assigned to a MT by STEM degree major,

and PST's grade level and content preferences. PSTs are also given the option to engage in their clinical experience independently or with a partner that is also enrolled in the course. All MTs, except for one, hosted multiple groups across different class periods. Table 1 summarizes the backgrounds of the MT participants including their teaching and content experience, their current teaching assignments, and number of PST's hosted for this study. As a limitation to this study, seven of our PST participants were placed with three MTs that engaged in the professional development but did not participate in the study.

Table 1
Alias and background of the six in-service mentor teacher participants

Alias	Teaching Experience	Content Experience	Current assignment	Number of PST's
Harriet	18 years	Math seven, math seven-eight, math eight, algebra one	Math eight and algebra one	1 team
Sue	18 years	Life science, physical science, Earth science	7th and 8th grade science	1 team
Jane	13 years	Math, computer science	GT program (algebra and geometry), algebra, math seven	2 teams
Amber	13 years	Elementary and middle school	Math seven and math seven-eight accelerated	2 teams
Sarah	16 years	Elementary school and middle school science	Seventh grade science- physical, life, and earth	2 teams, 1 individual
Justine	20 years	Physical science, Earth science, life science, biology, honors biology, AP biology, chemistry, honors chemistry, honors physics, AP physics 1, AP physics C, pre-college math, statistics and probability, anatomy and physiology	Honors chemistry, AP physics 1, AP physics c, and honors physics	1 individual

PST participants were enrolled in an undergraduate STEM education program and the PBI course. The course required a clinical experience where students spent time observing, lesson planning, and teaching a weeklong PBI unit. The PSTs taught in high school and middle school classrooms within their content area (math or science).

The MTs engaged in 8-hours of professional development that was divided between four, two-hour workshops on Zoom. Each meeting preceded a classroom visit of the PSTs to the MT's classroom. Workshops were focused on sharing roles and responsibilities of PST's and MT's during each upcoming visit, as well as digging deeply into teaching methods of project-based instruction and mathematical modeling and the five principles for effective mentoring. Table 2 provides an overview of the objectives for each professional development workshop with resources utilized. During the practicum component of the PBI course, MTs modeled teaching, shared feedback on lesson plans, and observed and shared feedback on the PST's teaching. Lesson plan feedback consisted of MTs reviewing PST's rough drafts and sharing recommendations regarding the various elements of the lesson plan template used for the course. These elements include alignment with the academic standards, clearly identified student learning objectives, development of inquiry-based essential questions that are culturally relevant to learners, identification of an anticipatory set/engagement, detailed information about the activities of the lesson including roles of teacher and learners and how lesson will differentiate to meet the needs of all learners, identification of a lesson closure, inclusion of formative/summative assessment deliverables, and list of the materials and resources needed for the lesson. Finally, MTs reviewed the overall projected timing of the lesson and suggested revisions based on their knowledge of their learners to be able to get through the planned tasks. PSTs were required to revise their plans based on MT and course instructor feedback. Teaching feedback consisted of MTs providing ratings and comments on specific aspects of the teach. These aspects include the categories of professional responsibility (i.e. promptness and professional dress), planning and preparation (i.e. organization of materials and time management), classroom environment (i.e. positive affect and respectful communication), and instruction (i.e. appropriate use of modalities, questioning, and scaffolding).

Data Collection

Data collection consisted of quantitative and qualitative survey data for the MT's and PST's before and after engagement in project activities. Surveys and interview protocols were developed by the research team. A sample of survey and interview questions are shared in Table 3.

Quantitative Data Collection. Surveys were conducted to gather data about MT's and PST's knowledge, experience, and perceptions of PBI and mentoring or being mentored. The surveys were administered before and following their engagement in project activities. The surveys varied between MT and PST participants to elicit the varied perspectives from each group. Both sets of surveys incorporated Likert-type scales (1 not confident - 5 extremely confident) to elicit self-ratings from participants.

Qualitative Data Collection. The surveys administered also incorporated open-ended question prompts to elicit additional insights pertaining to MT's and PST's knowledge, experiences, and perceptions of PBI and mentoring (MT) or being mentored (PST). These survey prompts were administered before and following their engagement in project activities. In addition to surveys, individual interviews were conducted by undergraduate student researchers on the

research team to MT participants following their engagement in the project activities. Interviews were conducted utilizing a semi-structured protocol, to prompt dialogue to develop a deeper understanding of the MT's experiences with PBI and mentoring. Interviews averaged to last approximately 35 minutes each. Interviews were audio recorded, transcribed, and member checked for accuracy. Due to time limitations, interviews with the PSTs were not conducted by researchers. In addition, while all MTs engaged in the professional development not all of them participated in the study. While this limitation resulted in less data collection from the MTs it did not impede the overall results of the study since MT and PST populations were analyzed independently.

Table 2
Overview of professional development workshops

Workshop	**Learning Objectives**	**Resources**
1	Share an overview of PBI (science) and Mathematical Modeling (math) as it relates to the course and share the roles and responsibilities of the PBI learner, mentor teacher, and University instructor. Identify the first 2 principles for effective mentoring and have MT's reflect on these principles in action.	Pelletier-Radford, C. (2017) *Mentoring in action: Guiding, sharing, and reflecting with novice teachers* (2nd ed.). Corwin
2	Identify the elements of Gold Standard Project Design and Teaching Practices and make PBI and Mathematical Modeling applications with math and science content standards. Identify the final three principles for effective mentoring and have MT's reflect on these principles in action.	Boss, S. and Larmer, J. (2018). *Project based teaching: How to create rigorous and engaging learning experiences.* ASCD
3	Identify the elements of Gold Standard Project Design and Teaching Practices in exemplar units shared. Considering teachers' current practices - strengths, challenges, and areas of growth will be identified for incorporating these instructional methods. Strategies and helpful tools will be shared to provide targeted and individualized feedback to preservice teachers on unit planning	Arnold, E.G. (2021). *Becoming a teacher of mathematical modeling: grades 6-12.* National Council of Teachers of Mathematics.
4	Discuss project reflection Strategies and helpful tools will be shared to provide targeted and individualized feedback to preservice teachers on teaching behaviors during the PST teaching week.	

Table 3
Sample of in-service mentor teacher and pre-service teacher survey and interview questions

Participant	Data Collection Tool	Sample Questions
MT	Pre/Post Likert	1. How do you feel regarding your knowledge of what is meant by Project-based Instruction? 2. How do you feel regarding your confidence of mentoring preservice teachers in Project-based Instruction? 3. How do you feel regarding the value of mentoring for mentor teacher professional growth in Project-based Instruction?
	Pre/Post Survey/Interview	*Background Information* 1. What content areas and grade levels do you have experience with? 2.Prior to this semester, what experiences have you had in learning and/or teaching project-based instruction/ mathematical modeling, if any? 3. How did the professional learning experience that you participated in this semester inform your knowledge of project-based instruction/ mathematical modeling? *Mentoring* 1. How did the professional learning experience that you participated in this semester inform your knowledge and/or practice of mentorship for preservice teachers? 2. How do you perceive the relationship dynamic between mentor and mentee? *Conclusion* 1. Regarding the professional learning this semester, how did you utilize the information shared in meetings and resources (such as the readings, feedback forms, etc)? 2. Share your feelings about your preparedness to host PBI preservice teachers this semester.
PST	Pre/Post Likert	1. How confident do you feel regarding your understanding of what is meant by Project-based Learning? 2. How confident do you feel regarding your ability to implement Project-based Learning? 3. How likely are you to incorporate Project-based Learning into your teaching repertoire if and when you have your own classroom?
	Pre/Post Survey	*Project Based Instruction* 1. Can you share your current understanding of project-based instruction? 3. Are there areas in project-based instruction that you feel confident? 3. Are there areas in project-based instruction that you feel you need to study in more depth?

	Mentorship Experiences 1. What qualities do you believe mentor teachers should possess in developing preservice teachers? 2. What aspects of mentorship have helped you the most in your development as a preservice teacher?

ANALYSIS OF DATA

We used qualitative discourse analysis (Eisenhart & Johnstone, 2008) to analyze the open-ended survey questions and interviews from the MT's. Researchers each read the transcripts and survey responses and participated in meetings to share noticing's in the data. These data sources were thematically coded and analyzed by the research group and results were sorted into thematic categories. Given the small sample size, descriptive statistics were used to analyze MT quantitative data while a paired t-test was used to analyze PST quantitative data.

As shown in Table 4, quantitative findings, while insignificant, evidenced growth in the development of PBI knowledge and pedagogy following PST participant engagement throughout the experience. Quantitative data analysis exploring the development of PBI knowledge and pedagogy of PBI PST's were insignificant, however overall growth was evidenced in both quantitative and qualitative findings (RQ1). Descriptive data analysis of the MT survey results also shows growth in confidence in areas related to PBI planning and implementation (RQ1). As shown is Table 5, MT's evidenced the most growth in confidence relating to assessment of a PBI unit and mentoring PST's (RQ1, 2).

Table 4
t test Results Comparing Preservice Teacher PBI Pre/Post Confidence

	Pre		Post		
	M	SD	M	SD	*t*-test
Knowledge	3.64	1.04	4.58	0.05	0.077
Implementation	3.29	0.97	3.95	0.73	0.152
Assessment	3.41	0.91	4.08	0.73	0.167

Table 5
Descriptive Results Comparing MT PBI Pre/Post Confidence

	Growth Mean	SD
Knowledge	1	0.57
Implementation	0.85	0.37
Assessment	1.14	0.37
Value of PBI in Content Area	1	0.81
Mentoring PST's	1.14	0.89
Value of Mentoring	1	0.81

Quantitative growth aligns with qualitative findings for MT's and PST's where there were positive shifts in confidence gains. Qualitative data analysis resulted in themes of increases in knowledge pertaining to theories and applications of PBI, increased confidence in teaching PBI,

and increased confidence in planning for PBI that foster a positive and productive learning environment (RQ1). For instance, as shared by a mentor teacher as an analogy for growth experienced, "the experience was like watering a plant, the plant was already there, but it got more nutrients to grow and adapt and became better than it was before." In addition to growth, we saw evidence of continued challenges and frustrations with teaching PBI effectively among the PST's. Some shared challenges with the time constraints of planning and implementing project-based experiences for students and assessing student achievement during PBI. One PST participant shared, "One of the inherent difficulties of PBI was scheduling time to create a project that implements all standards." Another PST participant commented that they would like more experience "just being comfortable around students in a PBI lesson" referring to the more open-ended and student-centered nature of the lesson. This comment is representative of an overall feeling from the PSTs of wanting more time in the classroom to get familiar with the expectations of the class and the student behaviors. This cohort of PSTs have had less clinical experiences than previous cohorts due to Covid protocols. Given that classrooms have resumed to normal school protocols, future cohorts will have additional clinical experiences that may lesson this feeling for PSTs.

Finally, MT's evidenced gains in mentoring attributes such as communication, sharing feedback, and flexibility when mentoring PST's (RQ2). As shared by a MT, "I learned how to give more effective feedback that better aligned with what they were learning in their coursework." As stated by another MT, "the PST brought in new perspectives, new ideas, and helped refresh my instructional approaches." These findings also align with the mentoring qualities identified by PSTs as being important in the mentor/mentee relationship. As stated by a PST, "it is important that the mentor be flexible in allowing us to try new things but be critical when the ideas may not work in their classroom with their students." Table 6 showcases the summary of MT and PST themes with evidence from the open-ended survey data and interviews. Overall, the qualitative data gave us more insight into the quantitative findings shed light onto areas of increased knowledge and confidence as well as areas of continued struggle.

Table 6
Summary of MT and PST Themes with Qualitative Evidence

Theme	Evidence
Knowledge MT and PST participants increased their knowledge pertaining to theories and applications of PBI	"[the professional learning] made me think back and reflect on what would be the best practices for PBI, then to give advice to those students [preservice teachers]." - Shawna (MT) "Before the course I thought that project based lessons were assigning students projects to do, however now I have a more detailed idea of what it is, what it looks like, and how as a teacher to plan, implement, and evaluate for project-based instruction." – Mari (PST)
Confidence in Application MT and PST participants increased their confidence in teaching PBI	"The chapter that I was in charge of presenting gave me a refresher of what I was doing and not aware of and what I needed to do that I wasn't aware of.. some of those strategies I forgot about."- Heidi (MT) "I had never done more than a single lesson plan before the course, and now that I have been through the stages of a whole

	unit I feel better prepared for doing project based instruction in my own classroom." – Christy (PST)
Confidence in Planning MT and PST participants increased their confidence in planning for PBI learning experiences	"The readings [from the professional learning] have good examples of PBIs that we can use..I got some good ideas, some good examples that I can use in my classroom and to guide my preservice teachers."- Sara (MT) "The process seemed daunting, but after doing it I have found that it has helped me with understanding NGSS better and developing lessons that are relevant, inquiry-based, and offer students voice and choice in their learning." – Sean (PST)
Communication, feedback, and flexibility MT participants felt better equipped with attributes to support PST development in the ways attributed as important by the PST's.	"The professional learning was helpful to me in sharing feedback that was specific to what the PST was learning in their classes." - Sara (MT) "I recognized the importance of being flexible with each PST assigned to me since they were both at different stages in their development and confidence in the classroom with students." - Shawna (MT) "It is important for the mentor teacher to be kind, positive, and supportive but also constructive with us so that we can improve" - Austin (PST)

CONCLUSION

Results for our research questions suggest that, while both MT's and PST's experienced challenges with implementing PBI, they felt an increase in their confidence in their knowledge, application, and planning for PBI within a classroom setting because of engagement in the course or the professional learning activities (RQ1). MT's appreciated the professional learning to "refresh" their knowledge of PBI that was better aligned with what the PST's were being taught (RQ1). Analysis of the data also suggests that the professional learning the MT's engaged in slightly increased their confidence in PBI knowledge and pedagogy as well as helped them develop a better understanding of mentorship roles (RQ1, 2). PST participants also evidenced some increases in confidence in multiple areas of PBI planning and implementation (RQ1).

As a pilot study to measure the impacts of professional development for MT's supporting PST's, it has been learned that professional development of MT's better situates them to support the unique needs of PST's during their undergraduate experiences in clinical based courses. Our findings align with existing research that confirms when the MT and PST are co-learners within a learning community, there are opportunities for professional learning through relationships within communities of practice (Riveros, Newton, & Burgess, 2012; Trevethan & Sandretto, 2017). This study contributes empirical evidence to the research base in understanding how to support MT's and PST's in general and more specifically as it relates to clinical coursework such as PBI.

The MT's that participated in this study were all experienced teachers with prior knowledge of PBI and experiences in mentoring. Findings from this study share how MT's experienced the professional learning in their continued development of PBI and mentoring. Future studies may investigate how MT's without prior knowledge and experience with a clinical based course would help extend the knowledge base regarding if and how professional learning on this topic may be beneficial to successful practicum experiences for PST's. Also suggested is future work that fosters

the mentor-mentee relationships in teacher education programs to better support the development of the MT and PST. Additionally, limitations of this pilot study, which include lack of interview data with PST participants and missing questions pertaining to the mentor/mentee relationship on the qualitative survey tool for MT's, could be incorporated to address these gaps in the qualitative data. Finally, it would be interesting to explore PST's experiences of working with MTs involved in course specific professional learning in the future.

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