Pre-Service Mathematics Teachers' Experiences with Proficiency-Based Learning

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Received 30 July 2016 Accepted 17 February 2017

Proficiency-based learning systems are becoming more common across the United States, yet few pre-service mathematics teachers have experienced this type of system in the classroom themselves. Teacher education courses are one opportunity for pre-service teachers to experience proficiency-based learning; however, we know little about the impact this type of experience might have. This study examines the experiences of six pre-service teachers in a secondary mathematics methods course implementing proficiency-based learning. Results show that the pre-service teachers experiences centred on four key affordances of the system (flexibility, multiple opportunities to demonstrate learning, awareness of progress and process, and awareness of gains in pedagogical content knowledge) and that they also identified challenges to its implementation.

Keywords · pre-service teachers · proficiency-based learning · mathematics methods courses

Mathematics teacher education programs play an important role in the success of reform movements by providing pre-service teachers with the knowledge and skills necessary to implement new initiatives (Manouchehri, 1997). Pre-service teachers in the state of Vermont are witnessing an interesting policy and practice shift with the passage of Act 77 in 2013 (Vt. Stat. Ann. Tit. 77, 2013). The legislation calls for personalised learning plans that include flexible pathways to graduation with the goal of enhancing postsecondary success. The legislation also alters the assessment and learning landscape. Starting with the high school class of 2020, all students in Vermont will meet graduation requirements through a proficiency-based system. In proficiency-based learning, students are assessed based on their level of proficiency on a set of clearly identified learning objectives enacted by the local school board. In contrast to learning and assessment structures where students receive credit for each completed class and generally earn a final numeric grade, a proficiency-based system allows students multiple opportunities to demonstrate proficiency based on assessments that are clearly tied to learning objectives. Completion of the requirement comes when students demonstrate proficiency. Targeted feedback and opportunities for students to reflect on their own learning are also central to the system (Le, Wolfe, & Steinberg, 2014).

For pre-service teachers, this system generally represents a shift from their prior learning experiences. It is a shift, however, that is gaining purchase across the United States with many states and school districts moving towards proficiency-based learning (Le, Wolfe, & Steinberg, 2014). It is worth noting that in the current literature similar initiatives go by different names

with competency-based, proficiency-based, and standards-based seen as relatively interchangeable. For states engaged in these remodelling efforts, regardless of the term being used, there is a shared understanding that "it is time to move away from traditional assumptions about how schools should look, how teachers should teach, and how students should learn" (Worthen & Pace, 2014a, p. 5).

This shift in assessment practices aligns with ongoing reform efforts in mathematics education, which emphasise conceptual understanding rather than rote memorisation of facts and procedures. In order to make the transition in instructional practices, mathematics teachers must make corresponding changes in the way they assess student learning, by focusing on formative assessment, providing frequent feedback, and allowing students multiple opportunities to demonstrate what they know (National Council of Teachers of Mathematics, 2013). Moving to a proficiency-based learning system, however, presents significant challenges for mathematics teachers (Tracy, 2005) and for teacher educators (Kalnin, 2014). Other attempts to shift away from the traditional assessment model, such as Australia's movement to outcomes-based education, have been met with criticism due in part to a lack of support for teachers (Berlach & McNaught, 2007). Thus, ensuring that all teachers, including pre-service teachers, have the knowledge and skills necessary to implement a proficiency-based learning system is critical and requires reconceptualising teacher preparation courses (Worthen & Pace, 2014b). Though this reconceptualisation will require significant work, "the single most important factor in the success of a personalised competency-based system is whether teachers have the opportunity to develop their expertise in competency approaches" (Le, Wolfe, & Steinberg, 2014, p. 22).

This study seeks to extend the understanding about proficiency-based learning, specifically how pre-service secondary mathematics teachers develop their professional skills and practices with a proficiency-based learning system with an eye toward supporting the development and delivery of mathematics curriculum within proficiency-based systems. To examine this, we followed six pre-service teachers during their secondary mathematics methods course, a course that used a proficiency-based learning system, and analysed their reported experiences.

Review of Literature

Traditional secondary mathematics grading practices involve assigning grades to student work based on percentages, taking all of the work over the course of a grading period into account, and computing some variation of a final overall average. Etsy and Teppo (1992) argue that this practice has negative implications for instruction, encouraging teachers to break content down into discrete skills that can be assessed separately. Further, they suggest that the averaging approach to calculating a final grade does not take into account the very nature of learning; students' understanding, in fact, develops over time and not every student should be expected to master every concept immediately. Students who take longer to learn a concept are penalised under the traditional grading system, as their initial grades are averaged in with later ones. Consequently, they are often labelled "low attaining," and rather than continually challenging these students, teachers often focus instead on remediation (Watson, 2002). Changing traditional assessment structures may encourage more students to move into higher-level mathematics (Brown, Brown, & Bibby, 2008). Ideally, learning and assessment should identify ways that students work toward mastery of concepts, focusing on what students can do and emphasising opportunities to grow and improve.

Proficiency-based learning systems use methods of instruction and grading that are centred on continued development which means that they are flexible and responsive to student needs. There is not one single agreed upon definition for proficiency-based learning, and proficiency-based systems can look different depending on the region, school, or even teacher (Proficiency-Based Learning, 2016). For the purposes of this paper, we base our conceptualisation of proficiency-based learning on key principles identified by the Great Schools Partnership (2016). Drawing from these principles, we focused on the following characteristics: proficiency-based learning systems include clearly communicated learning expectations against which achievement is evaluated; formative assessments are tied to those learning expectations; and learners have multiple, varied opportunities to demonstrate learning. These common characteristics are all supported by research. Clear learning targets promote learning and have a positive impact on student perceptions of their learning environment (Seidel, Rimmele, & Prenzel, 2005). Formative assessment and targeted feedback can support learning and increase academic achievement (Black & Wiliam, 1998; Shute, 2008), and allowing students to resubmit work can foster positive attitudes towards learning (Posner, 2011).

Rigelman (2015) argues that a proficiency-based approach aligns with meaningful maths instruction, particularly problem-based learning models. The attention to clear learning goals in proficiency-based systems can provide guidance for teachers facilitating problem-based lessons. Likewise, the emphasis on actively reflecting on one's performance relative to learning goals supports the mathematical habits of mind that learners need to be successful. However, transitioning to proficiency-based learning is not easy. Tracy (2005) followed twelve middle level maths teachers transitioning to a similar assessment system. Those teachers found it challenging to implement the system fully, and they found it difficult to use a different form of assessment than the other teachers at the school. At the end of the study, only two teachers chose to continue using the new system, highlighting the need for ongoing professional development and support. Coe (2012) studied an entire middle school transitioning to a standards-based grading system and also found the transition to be difficult, even in a whole school context. The teachers did not have adequate time to prepare for and work on the new system. They lacked the appropriate technology to support their work, and they had difficulty alleviating parent anxiety. The teachers also struggled with low homework completion rates. A maths teacher at the school did identify several positive changes, however. Students spoke differently about learning, focusing on their abilities and understandings rather than letter grades. Clear learning objectives also prompted the teacher to reflect more on her practice and enabled students to be more creative in how they demonstrated understanding.

Goos and Moni (2001) argue that it is important for teacher educators to model the assessment practices they want pre-service teachers to use. Further, pre-service teachers' assessment literacy has been shown to be weak in general (Siegel & Wissehr, 2011; Volante & Fazio, 2007) and more specifically, math teachers have been shown to lack a strong understanding of the core principles of standards-based grading (Tierney, Simon, & Charland, 2011). In addition to exposing pre-service teachers to progressive assessment practices, modelling and discussing proficiency-based assessment also presents an opportunity to deepen the assessment knowledge and skills of pre-service mathematics teachers.

Research on proficiency-based learning in teacher education courses is limited. In her efforts to use proficiency-based assessment in an elementary education course, Kalnin (2014) found a dearth of resources for teacher educators. Nonetheless, she anecdotally reported that it was easier to teach about proficiencies since the pre-service teachers were experiencing them. The research that does examine proficiency-based assessment within teacher education is focused on its role in the student teaching experience. Tang et al. (2006) found, for example, that

when student teachers and supervisors used a progress map to track movement towards proficiency, expectations for the student teachers were made clear. Additionally, Montecinos et al. (2010) found that a standards-based assessment rubric enhanced student teacher professionalism and supported learning. Building on this work, this study aims to address the absence of research on proficiency-based learning in pre-service teacher education courses (outside of student teaching) by investigating the experiences of pre-service teachers with a proficiency-based learning system in a secondary mathematics teacher education course.

Methods

In order to better understand pre-service teachers' experiences with proficiency-based learning in a secondary mathematics methods course, we used case study methodology to investigate the following research question: What were the pre-service teachers' experiences with proficiency-based learning? The case study approach was a strong fit since it allows for an in-depth look at a bounded system (Yin, 2013), which in this case is defined by the specific implementation of the proficiency-based learning system in a given course and the experiences of the pre-service teachers within that course. In this sense, the case is an instrumental case in that it is used "to understand a specific issue" (Creswell, 2012, p. 98). Given that this case study examines a specific experience within a particular context, the findings are not generalisable. However, the findings may be transferable to other settings. The first author was the instructor for the secondary mathematics methods course; the other researchers made up the research team. While the first author was primarily responsible for designing and implementing the proficiency-based learning system, the entire research team collaborated on data collection and analysis.

Context and Participants

This study took place within the context of a semester-long, secondary mathematics methods course using a proficiency-based learning system for the first time. The course was designed for pre-service teachers who are working towards licensure in secondary mathematics (grades 7-12). The course met once a week for three hours in the evening. The participants in the study included all six pre-service teachers (four female, two male) enrolled in the course. Two of the pre-service teachers were seniors, and they were enrolled concurrently in their student teaching internship; the remaining four pre-service teachers were juniors. While all of the pre-service teachers had been exposed to the idea of proficiency-based learning during their time in the education program, none of them had previously taken a class using a similar system.

Data Collection

In order to understand the central issues of the case (Creswell, 2012), we collected data from three different sources: pre-service teacher reflections, pre-service teacher interviews, and course materials (e.g. the rubrics used for self-evaluation and feedback). Over the course of the semester, we gathered two written reflections in which the pre-service teachers were required to consider and analyse the use of the proficiency-based system in secondary mathematics classes. The course instructor kept researcher memos in the form of a weekly journal, documenting the implementation of the proficiency-based system and observations of the students' experiences with the system. Data from the researcher memos were used primarily for building the case description. At the end of the semester, the fourth author administered a

virtual, non-standardised interview (Turney, 2008) to the class. Since the course instructor was also part of the research team, we took steps in order to minimise any impact on responses from potential power dynamics. The fourth author walked participants through the consent process. They were told that the course instructor would not have access to their consent form or their responses to the interview questions until after course grades were submitted. All of the pre-service teachers in the course chose to participate. It took the participants approximately ten minutes to respond to six open-ended questions. The questions asked them to describe their previous exposure to proficiency-based learning, the ways in which proficiency-based learning supported and/or extended their learning in the methods course, their perception of their level of preparedness to implement a proficiency-based learning system, and modifications that would enhance the proficiency-based learning system they experienced (see Appendix).

Data Analysis

The research team began data analysis by coding the responses to the virtual interview. Each team member used an open coding (Benaquisto, 2008) process to code the data and identify emerging themes. The team then met to discuss codes. Using interpretive convergence (Harry, Sturges, & Klingner, 2005), we reached consensus on a final set of codes that were identified on the basis of frequency of data. Using our research question as a guide, we also focused on codes that illuminated something unique about the pre-service teachers' experience in a proficiency-based system. We then grouped these codes into six broad categories. We used these categories to individually code the pre-service teachers' reflections. We then pulled all coded data into tables based on the identified categories. Coding was compared across researchers using a shared data display and any discrepancies were discussed until agreement was reached. The final set of five codes resulted in the identification of the themes discussed herein.

Case Description

The following case description provides an overview of the proficiency-based learning system as it was enacted. We also explicate the implementation of the system.

The Proficiency-Based Learning System

The course instructor established a set of learning objectives for the course after consulting the National Council of Teachers of Mathematics' (NCTM) 2012 Council for the Accreditation of Teacher Preparation (CAEP) Standards for initial secondary mathematics teacher preparation. The instructor analysed these standards, identified those relevant to the course objectives, and created twenty learning objectives in which pre-service teachers would be required to demonstrate proficiency.

With the learning objectives in place, the instructor created a rubric for each learning objective with four levels of proficiency: "I'm just starting," "I'm making progress," "I can do this," and "I rock this." By the end of the semester, the instructor intended for all pre-service teachers to achieve at least the "I can do this" level of proficiency for each learning objective.

For each pre-service teacher, the instructor created an individual Google Doc, which was shared only between the instructor and the pre-service teacher. The Google Doc included the proficiency rubric (See example in Figure 1).

Proficiency	I'm just starting.	I'm making progress.	I can do this.	I rock this.	Comments
I can facilitate mathematical discussions centred on key ideas.		• I facilitate teacher-student interactions. • I plan and use mainly low level questions.	• I facilitate teacher-student and student-student interactions. • I plan and use high and low level questions. • I use the five steps for orchestrating a math discussion in planning and implementing my lessons.	• I facilitate teacher-student and student-student interactions. • I plan and use high and low level questions. • I use the five steps for orchestrating a math discussion in planning and implementing my lessons. • I implement systems for tracking and evaluating student participation.	

Figure 1. An example of a learning objective and its four levels of proficiency.

During the semester, pre-service teachers completed course activities that were aligned to specific learning objectives. In one assignment, for example, pre-service teachers designed a lesson and taught it to their peers. As they designed and taught the lesson, pre-service teachers focused on demonstrating proficiency on a specific subset of the learning objectives. The formative feedback provided to pre-service teachers was not a single numeric grade; rather, feedback was based on how the work could be improved in relation to the corresponding learning objectives.

When a pre-service teacher determined that they had reached the "I can do this" level of proficiency for a particular objective, the pre-service teacher submitted evidence of their learning, drawing from his or her classwork (including, but not limited to, lesson plans, class activities, reading reflections, and video recordings of their teaching). For example, a pre-service teacher might submit the aforementioned lesson plan assignment along with an analysis of why it provides evidence of proficiency in a particular objective. After evidence was submitted, the instructor reviewed the it, evaluated the pre-service teacher's level of proficiency, and provided feedback to the pre-service teacher on the rubric in the pre-service teacher's Google Doc. For example, one pre-service teacher submitted the written lesson plan assignment as evidence that the pre-service teacher could plan both low- and high-level questions. However, the lesson plan revealed that the pre-service teacher had only planned low-level questions for the class discussion. The instructor's feedback referred the pre-service teacher to Bloom's taxonomy and to a class reading on levels of questioning and asked the pre-service teacher to revise the lesson plan and develop high-level questions that could be used to extend pre-service teacher thinking.

If a pre-service teacher submitted an assignment that did not reach the "I can do this" level of proficiency for the target learning objectives, then the pre-service teacher was allowed to revise and resubmit the assignment without penalty. Each pre-service teacher was asked to revise and resubmit work on an average of six different times over the course of the semester.

At the end of the semester, each pre-service teacher's final grade was determined based on the number of learning objectives out of twenty for which they had reached proficiency. For example, a pre-service teacher would earn a B for reaching the "I can do this" level on all twenty learning objectives. To earn an A, a pre-service teacher would have to reach "I rock this"

level on at least seven learning objectives with the remaining objectives at "I can do this." At the end of the semester, all six pre-service teachers earned an A in the course.

Implementation

On the first day of class, the instructor introduced the proficiency-based learning system. In addition to giving a rationale for its implementation, the instructor explained how the system would work. After offering extended time for pre-service teacher questions, the first class activity was for pre-service teachers to review the proficiency rubric and complete a pre-assessment, analysing their level of proficiency for each learning objective at the beginning of the course. In general, most of the pre-service teachers assessed their abilities at the "I'm just starting" or "I'm making progress" level on the majority of the learning objectives.

Throughout the semester at the beginning of nearly every class, the instructor set aside time to check in with the pre-service teachers in relation to their experiences with the proficiency-based learning system. This provided pre-service teachers a chance to report on how the proficiency-based system was working, and it pushed pre-service teachers to consider aspects of implementation from an emerging teacher's perspective since those pre-service teachers who found employment in Vermont would be using proficiency-based assessment in their school. Over the course of the semester, the pre-service teachers wrote weekly reflections, and two of those reflections focused specifically on their perspectives of the use of proficiency-based systems in secondary mathematics classrooms.

The instructor dedicated the ninth week of class to studying assessment, and a significant part of that class focused on analysing proficiency-based learning systems and considering their implementation in secondary mathematics classes. At the end of the semester, the pre-service teachers responded to questions about their experiences with the proficiency-based learning system.

Results

Our analysis of pre-service teacher reflections and pre-service teacher interviews revealed five major themes that resulted from pre-service teachers' experiences with the proficiency-based learning system. Four of the themes identified affordances perceived by the pre-service teachers (flexibility, multiple opportunities to demonstrate learning, awareness of progress and process, and awareness of gains in pedagogical content knowledge) and one theme identified challenges.

Flexibility

Four of the six pre-service teachers noted that the proficiency-based system provided more flexibility in the way they learned and were assessed. The pre-service teachers enjoyed the individualised, self-paced nature of the system, which gave them more control over when they completed work. While each assignment had a specific due date, there was no penalty for turning in an assignment late, which allowed pre-service teachers some flexibility during busy times in the semester. One pre-service teacher explained, "Since I took this class while student teaching, I really liked the proficiency-based assessment system since I was able to complete work when it fit my busy schedule." Another pre-service teacher indicated that the "learning was independent and allowed for completion when you had the time." Pre-service teachers also recognised that the flexibility around timing and completion allowed pre-service teachers to

engage in differentiated learning experiences. One pre-service teacher wrote that the flexible system "more easily allows for differentiation, since certain students may take longer to achieve certain proficiencies, while others can pursue tasks that require higher cognitive demands if they have already mastered specific topics."

Pre-service teachers also enjoyed the flexibility they were given over how to demonstrate their proficiency. Throughout the semester, while pre-service teachers could choose to complete assignments designed by the instructor, they were also free to showcase their learning in different ways. Some pre-service teachers, for instance, decided to share their understanding of how to use the Common Core State Standards through a written reflection with attached sample lesson plans while others demonstrated the same skills through individual interviews with the instructor. Many of the pre-service teachers reported that if they were using a proficiency-based learning system in their own classes, they would replicate this feature. Envisioning her future classroom, one pre-service teacher wrote: "At any point in time, a student could show me something or have a conversation with me in order to show they are proficient." This view of assessment represents a considerable shift from traditional modes of assessment where pre-service teachers are typically assessed through formal assessments that are pre-identified by the instructor.

Multiple Opportunities to Demonstrate Learning

Our results indicate that pre-service teachers appreciated having multiple opportunities to demonstrate their proficiency. In their reflections, all of the pre-service teachers addressed the importance of having multiple opportunities to show their learning. In particular, pre-service teachers felt that this aspect of the proficiency-based learning system reduced stress and shifted the emphasis away from a testing paradigm to one of progress over time.

As noted in the case description, during the semester, each pre-service teacher was asked to revise and resubmit work an average of six times. However, rather than feeling like this process to meet proficiency was extra work, feedback indicated that the opportunity to resubmit reduced the stress associated with assessment. For example, one pre-service teacher noted that the assessment process "takes a lot of the 'test stress' away because there will be many small assessments" while another pre-service teacher explained that the process "was also really nice because when I did not fully show I was proficient at something during one task, I was able to develop further and then show I was proficient when I felt I was ready."

Pre-service teachers also reported that learning felt emergent and ongoing since they were able to revise and resubmit. One pre-service teacher asserted, for example, that the proficiency-based system allowed "room to show constant improvement" while another wrote, "I like the idea of recognising the importance of progress and that learning isn't over after the assessment." Another pre-service teacher likened proficiency-based learning to her experience with sports, sharing that "[in] using a system like this outside the classroom, I have found I have excelled. For example, playing a sport you continuously practice and get better and always have another chance such as another season, another game, another tournament with more answers." In this way, providing multiple opportunities for pre-service teachers to show their learning seemed to place an emphasis on progress over time and continuous learning, which pre-service teachers appreciated and enjoyed.

One particular pre-service teacher interaction provides a nice illustration of the role that multiple opportunities for revision can play in learning. While most pre-service teachers were able to revise their work to demonstrate proficiency on the first try, in one instance a pre-service teacher submitted work, received feedback, and resubmitted work that was still not proficient.

The instructor then met with the pre-service teacher to discuss her progress. In the meeting, the instructor shared her interpretation of the pre-service teacher's areas of understanding and weaknesses, regarding the specific learning objective. The pre-service teacher agreed with the assessment and asked if she could see some high-quality examples that would illuminate the areas in which she was struggling. After viewing the examples, the pre-service teacher had an "ah-ha!" moment and quickly began describing what she could have done differently in her own work. Her next revision, which took into consideration her fresh thinking, demonstrated proficiency in the learning objective. That pre-service teacher later wrote that the proficiency-based system helps pre-service teachers "to succeed and feel more motivated" because they can "go back and get reassessed on [an] objective so they can 'master' the topic." This interaction also suggests that the multiple opportunities provided in proficiency-based learning systems may create a context for dialogue concerning teacher feedback, which ultimately benefits student learning.

The impact of these multiple opportunities was also evident when pre-service teachers envisioned their future practice. One pre-service teacher stated, for example, that he would "allow students to take retakes on material they needed more time on after they have done practice problems to improve their skills." Likewise, another pre-service teacher shared the following regarding her own emerging philosophy: "If this information has not 'clicked' yet, then they [her future students] should have the opportunity to continue to work on their mathematical understanding." These articulations suggest that pre-service teachers not only appreciated having multiple opportunities to demonstrate their learning but that despite this being a non-traditional practice, they were already beginning to envision what this might look like in their future classrooms.

Awareness of Progress and Process

The pre-service teachers reported an increased awareness of 1) the progress they were making towards meeting course objectives and 2) the process by which their grades were being determined. This awareness of progress and process resonated in a number of ways across the data.

In addition to reporting that the proficiency-based learning system made learning objectives clear, pre-service teachers appreciated the transparent alignment of coursework to learning objectives. They particularly appreciated how each learning activity was clearly aligned to a learning objective, allowing them to focus their attention. One pre-service teacher explained how "[t]his type of assessment really made me more aware of what was expected of me and what needed to be done in order for me to complete the class." Another identified how the system focused learning: "With every assignment I completed, I knew what I was supposed to be learning, so I could be entirely focused upon that proficiency/objective/etc."

Pre-service teachers also recognised that the system offered a chance for targeted instructional opportunities with benefits for both the instructor and the students. One pre-service teacher reflected that through proficiency-based learning, students "are able to see where they need more practice and spend extra time working on concepts of their choice in order to get to the point where they can show they are proficient." Pre-service teachers also articulated how this increased awareness would help them make instructional choices as future teachers. For example, one pre-service teacher wrote that "[s]tandards-based grading gives the teacher important insight into his/her instruction, and really allows assessment data and results to shape the way in which instruction moves forward." In other words, pre-service teachers felt that the system would help make their instruction and feedback more individualised,

particularly once they discerned strategies to closely track student progress in their future classrooms.

This in turn influenced several pre-service teachers' visions of their future teaching. For example, one pre-service teacher wrote, "Each day, I would always have my list of standards and student names with me so I could just make check marks when I see that a student really knows one of the standards well." Pre-service teachers recognised that teachers could use this information to make instructional choices with dexterity from one day to the next, as one articulated: "Assessment can be small so any amount of free time can be used to achieve this mastery and it is not intimidating."

Throughout the semester, pre-service teachers recognised the dynamic relationship between feedback and multiple opportunities to advance learning. One pre-service teacher wrote that with a proficiency-based system, "feedback is usually more essential than it is with traditional grading, since students are given the opportunity to revise their work until they have demonstrated proficiency of a particular standard." This recognition of the ongoing cycle of feedback and revision suggests that experiencing the proficiency-based system, which emphasised revision and growth, deepened understanding of the critical role that targeted feedback plays in learning.

Awareness of Gains in Pedagogical Content Knowledge

In addition to demonstrating proficiency in each learning objective by the end of the semester, pre-service teachers were able to accurately report what they had learned. When asked to reflect on their learning through the proficiency-based learning system, all but one identified various ways in which the system contributed to their mathematics pedagogical content knowledge. The pre-service teachers reported gains in 1) their abilities to interpret and apply their understanding of the Common Core State Standards to support student learning, 2) their ability to anticipate student thinking and support mathematical reasoning, and 3) their ability to facilitate mathematical discussions.

In their reflections, several pre-service teachers also cited evidence from their Google Doc, demonstrating the progression of their understanding on specific learning objectives over the course of the semester. The following examples are excerpted from pre-service teacher reflections: "I learned what it actually meant to facilitate a mathematical discussion. I had to incorporate different techniques in order to demonstrate my proficiency"; "I figured out how to prompt students without giving them the answers, without them responding with simple answers, that forced them to think critically and justify their answers"; and "This proficiency really helped me to focus my lesson planning on being tied directly to standards." The instructor's observations and analyses of student work supported these reflections. Concrete gains in pedagogical content knowledge are, of course, important for pre-service teachers enrolled in a mathematics methods class. That these pre-service teachers were aware of these gains suggests a level of reflection and metacognition, which we infer may be connected with the previous theme in that they were engaged in the process of determining their learning progress.

Challenges

Though perceptions were positive overall, the pre-service teachers did acknowledge several challenges associated with implementing a proficiency-based system.

They expressed concerns with the amount of work that it would take to implement. For instance, one pre-service teacher wrote: "I learned that it is a lot of work to keep track of." In

their reflections, they made frequent reference to the amount of work that they perceived the teacher instructor was dedicating to transitioning to the new system with a small class of six students. This was especially problematic when pre-service teachers considered their future classrooms. One pre-service teacher wrote "[i]mplementing this method in a school with 25 students per class, that may be very difficult and may need some modifications," and others expressed concern about their ability to use a proficiency-based system with more than one hundred students, a typical teaching load for secondary teachers.

There were some concerns relating to the nature of the shift in the pre-service teacher's role within the proficiency-based learning system. One wrote, "the major disadvantage is that standards-based grading is a new system that some people are not familiar with, so it might be difficult for students to experience significantly different grading systems from teacher to teacher." Some pre-service teachers worried, as well, about the ability of secondary students to transition to a new assessment system, as many students are not used to having to continue working until they have mastered a learning objective. One pre-service teacher wrote, "Students are so used to being able to pass something in and say they're done that they may not have the motivation to work towards 'mastery' of concepts."

Another challenge pertained to understanding the nuances of the proficiency-based learning system, specifically with regards to assessment. One pre-service teacher found it especially challenging, for example, to discern the difference between the levels of proficiency, writing: "I'm not sure that the difference between 'can do' and 'rock this' was very clear." In general, the challenges were generally focused on practice and process of a proficiency-based learning system, not concerns about the efficacy of the system.

Implications and Conclusions

The study shows that pre-service mathematics teachers enrolled in a methods class discerned a number of affordances through their experiences with a proficiency-based system, specifically: flexibility, multiple opportunities to demonstrate their learning, an awareness of progress and process, and gains in content pedagogical knowledge. These affordances have implications for youth attending school and pre-service teachers who will soon be teaching.

When considering learning opportunities for university students enrolled in a mathematics methods class, the affordances highlight how endemic traditional assessments processes are across teacher preparation. In fact, this underscores the prevalence of traditional systems of assessment in higher education which emphasises the need for additional exposure to proficiency-based learning in higher education among pre-service teachers, particularly since emerging teachers will be expected to practice in systems that are committed to proficiency-based learning. This exposure, of course, runs counter to the extensive apprenticeship of observation (Lortie, 1975) with traditional modes of learning and assessment both within traditional teacher preparation programs and the content offerings across higher education.

The results of this study point to several implications for maths teacher education. First, the benefits and challenges identified by the pre-service teachers involved in this study suggest that exploring and experiencing proficiency-based learning provides a rich opportunity for pre-service teachers to examine their own beliefs about assessment with an eye toward improving student outcomes. This metacognitive awareness is an important outcome as it underscores the significant role that the assessment practices of teacher educators can have in impacting and in some cases disrupting, pre-service teacher beliefs about assessment.

Second, even with just one initial exposure, pre-service teachers were already developing thinking around proficiency-based learning and assessment; this is impressive, particularly given that the methods course was taken near the end of their program of study. This raises the question about the effects of a more thorough integration of proficiency-based learning across the entire professional sequence of courses. Further, it affirms the power of modelling teaching practices within a methods course, referred to as second-order teaching (Murray & Male, 2005). Professional learning communities advance learning outcomes when they focus attention on the second order changes. In this case, the aforementioned affordances shift the conversation and offer value to proficiency-based learning, and Linda Darling-Hammond and her co-authors make a cogent argument for the "importance of program coherence" (p. 391) in "The Design of Teacher Education Programs."

Lastly, given the challenges of scale, further research is necessary to align the work done in teacher preparation to the demands of implementation in schools. This will not only address pre-service teacher concerns about scalability, it will also assist in the rollout of proficiency-based learning and assessment in Vermont, a state that has a legislative mandate to adopt proficiency-based assessment. Part of this inquiry should also look to discern whether proficiency-based learning and assessment improves student outcomes.

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Appendix

Student Questionnaire

1. In general, what did you learn from the experience using proficiency-based assessment in this course?
2. In what ways did the proficiency-based assessment system support and/or extend the content you were learning about in the course?
3. What other experiences have you had learning about, experiencing, or observing proficiency-based assessment outside of this course? What did you learn from those experiences?
4. Describe your level of preparedness for implementing proficiency-based assessment as an instructor in your future class.
5. Select 2 or 3 course proficiencies, and describe how your understanding of each developed over the semester.
6. What modifications would you suggest to enhance the proficiency-based assessment system used in this particular class?

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