COMMUNICATING PROFESSIONAL NOTICING THROUGH ANIMATIONS AS A TRANSFORMATIONAL APPROXIMATION OF PRACTICE

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This paper explores the use of animations as an approximation of practice to provide a transformational technology experience for elementary mathematics preservice teachers. Preservice teachers in mathematics methods courses at six universities (n=126) engaged in a practice of decomposing and approximating components of a fraction lesson. Data analysis focused on the extent to which preservice teachers were specific or general with respect to mathematics in written and animated accounts of noticing. Findings illuminate preservice teachers' degrees of specificity, with most preservice teachers being more specific about mathematics in their animations, showing promise for animation as a tool for communicating what is noticed. Further, preservice teachers perceived the use of animations a transformational experience, meaning the technological medium provided learning and access beyond what could have been accomplished without the technological support.

Keywords: Teacher Education-Preservice, Technology, Instructional Activities and Practices

As technology changes, new advances permeate teacher education programs and traditional methods of teacher preparation. These recent developments have "made feasible the rich presentation of classroom processes in a way that can capture much of the complexity inherent in education" (Miller & Zhou, 2007, p. 332). For example, showing video of classroom scenarios provides an opportunity for preservice teachers (PSTs) to view a setting they otherwise may not have observed. These technologies afford PSTs growth in learning from the technology and in learning how to use the technology. As teacher educators consider how they will teach their methods courses, they must recognize the role of technology in the process and maintain cognizance about the affordances and constraints of such innovations. The purpose of our study was to analyze the role technology played to support the specificity of PST noticing. We analyzed PST noticing to gain an understanding of affordances and constraints for the incorporation of technology within a mathematics methods course and answered the following questions: (1) How does the technological medium of animation as an approximation of practice enable specific communication of PST noticing?, and (2) Based on these findings, does the animation technology replace, amplify, transform or hinder written processes? We use the term *methods courses* to refer to university or college courses that prepare future teachers on the pedagogical approaches for teaching a specific content area. In this paper, we specifically focus on elementary mathematics methods courses, meaning those courses designed to prepare future elementary teachers with research-based methods for teaching mathematics.

Theoretical Framework

As teacher educators prepare courses and consider the incorporation of technology, it is important they are aware of the function of technology in their courses. Cognizance of the intent of technology integration is integral for positive outcomes for PSTs (Amador, Kimmons, Miller, Desjardins, & Hall, 2015; Hughes, Thomas, & Scharber, 2006). Teacher educators should consider how technology infused into the course functions, meaning the extent to which it is replacing (R), amplifying (A), or transforming (T) current methodological practices (Hughes et al., 2006). If a technology takes the place of a process currently performed without technology, it is considered replacement (R). When a technology adds to a current practice in a methods course, amplification (A) occurs. Finally, when a technology provides opportunities that could otherwise not be accomplished without the given technology, transformation (T) takes place. Coupled with this framework of replace, amplify, and transform (RAT), some researchers have proposed hindrance (H) as a fourth technology function, claiming that not all technology incorporation is positive (Amador et al., 2015). Consequently, we frame our work theoretically with the Hughes et al. (2006) RAT (replace, amplify, transform) model with the addition of H (hindrance) as a lens for understanding the role of technology in supporting PSTs' development of research-based practices.

Related Literature

A variety of techniques, ranging from traditional drawings to GIF environments, can be used to produce an animation that depicts the phenomenon of movement. For this research, animation refers to the use of a digital medium in which a sprite (Amador & Soule, 2015) is manipulated and speaks audible utterances and the sequence of interactions is playable. Animation can be used to generate fictional interactions, such as classroom episodes, or can be produced by the teacher educator and provide straightforward depictions of a concept or practice, which can be productive when helping novices learn (Chazan & Herbst, 2012). For example, Chen (2012) had PSTs create comic-based lesson depictions to describe the nature of teaching. Similarly, Herbst, Chazan, Chen, Chieu, and Weiss (2011) argued for the use of Lesson*Sketch*, a comic-based representation, as a way to support PSTs in making decisions about teaching. As Hoban and Nielsen (2013) indicated, "animations could provide a motivation for engaging with content if learners became the designers and creators rather than consumers of information as in expert-generated animations" (p.121). Although our focus was not to explore PST motivation and engagement, we were interested in exploring how the use of PST-generated animations could provide a window into PST noticing to support communication about what they notice.

Professional noticing is fundamental to the work of teaching (Sherin, Jacobs & Philipp, 2011), and many instances simultaneously demand teachers' attention and impact teachers' decisions (Star, Lynch, & Perova, 2011). Research indicates that differences exist between novice and expert teachers' noticing skills, where veterans are more adept at interpreting a situation and novices tend to be descriptive and miss key elements (Huang & Li, 2012). Research also indicates that it is possible to improve PST noticing with support (Schack et al. 2013). As a result of studying the development of noticing among PSTs, Star et al. (2011) argued that teacher education programs should explicitly teach PSTs to notice. We were interested in studying what the use of PST-generated animations could enable in regards to their noticing, so that we as teacher educators could better support PST development of this complex skill.

Within practice-based teacher education, the primary goal of a methods course is to develop PSTs' professional practices in a specified content area, meaning the focus is on PSTs learning to do the work of teaching (Grossman, Hammerness, & McDonald, 2009). Grossman and colleagues (2009) developed a framework for pedagogies of professional practice to conceptualize processes that support teachers' development of professional skills. This framework includes three elements: representations, decompositions, and approximations of practice. Approximations of practice are opportunities for PSTs to enact one or some practices of teaching themselves with scaffolding. Turning again to technology, various technological mediums have been used as a way to approximate practices with the aim of enhancing PSTs' development of professional practices. One example of this is the use of simulations, including SimSchool, which is an on-line teaching application (Gibson, 2007) as well as the TeachLive program (Dieker, Rodríguez, Lignugaris, Hynes, & Hughes, 2014). These technological features, including animation, provide an advantageous way for PSTs to engage

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in an approximation of practice and simultaneously provide us, as teacher educators, insight into their noticing.

Method

PSTs (n=126) from mathematics methods courses at six universities in the United States participated in a task involving the use of animation. Data for this study come from a larger study, and were analyzed to measure PST noticing to further understand the specificity of noticing that existed across the different mediums employed, namely written records and animations. To design and implement the task, we built on previous literature of professional noticing in the context of methods courses (e.g., Star et al., 2011) by using video, and added the use of PST-generated animations. The project design involved three phases.

Phase One: Task Design

In Phase One, we created a task to provide insight into PSTs' noticing that could be administered in each of the six methods courses. We showed the PSTs a video clip from a mathematics classroom that featured a student-centered classroom and included segments of elementary students sharing their mathematical thinking. We used the publicly available video, *Cookies to Share*, (http://www.learner.org/resources/series32.html). The PSTs were required to watch the clip (beginning to 13:45) in class, identify a pivotal moment of student(s)' mathematical thinking specific to mathematical learning or teaching, and then record this moment in writing. After writing about what they noticed, preservice teaches created their own scenes of the most pivotal moment they noticed using the website, goanimate.com. Goanimate is a cloud-based platform for generating and disseminating animated videos. Figure 1 is a screenshot of an animation. The intent of this design was to provide opportunities for PSTs to communicate what they noticed from the video through written and animated mediums.

Figure 1. Goanimate screenshot example.

Phase Two: Task Implementation

For Phase Two, the task was administered in one section of an elementary mathematics methods course at each of six different universities during the fall 2013 semester. The exact timing of project implementation within the semester schedule was left to the discretion of the individual methods course instructors. The methods instructor of the respective methods course administered the project him or herself. The data set included all of the PSTs' written responses, animations, and transcriptions of the animations: 126 written documents and 106 animated videos in all. It should be noted that due to limited access to technology PSTs in one teacher educator's class did not animate the written medium, thus accounting for the difference between the written and animation data.

Phase Three: Data Analysis

In Phase Three data were analyzed to measure PST noticing and further understand the specificity of noticing that existed across the different sections of the elementary mathematics courses and the different mediums employed. First, we analyzed each written account and animation with a focus of whom and what PSTs noticed, using the coding framework in Figure 2, adapted from (DeAraujo et al., 2015). Each data item was coded as one of the following: Teacher General Noticing, Teacher Specific Noticing, Student General Noticing, or Student Specific Noticing.

	Teacher		Student	
WHO	Attend to the Teacher		Attend to Whole Class Attend to a Group of Students or Attend to a Student	
WHAT	**GENERAL** Focus on General Teaching Strategies, Pedagogy, Content of a Lesson, Context of a Problem	**SPECIFIC** Focus on a connection between the teacher and another person(s) or aspect (e.g. pedagogical strategies interactions	**GENERAL** Focus on general actions, aspects, ideas, topics, lesson structure or contextual features (e.g. physical environment, home environment, dispositions, etc.)	**SPECIFIC** Focus on a connection between a student and another person(s) or aspect (e.g. his/her mathematical thinking, his/her interactions with others, or specific teaching strategies)

Figure 2. Framework for Level One coding, general or specific.

Following the Level One coding, we were interested in knowing more about the content of the data items coded as specific to understand what the PSTs were identifying as pivotal. We coded these data using a Level Two Coding Framework that included the following codes: 1) Addition, 2) Slope, 3) Fair Sharing, 4) Justification, 5) Procedural Explanation, 6) Written Notation, 7) Clarification, and 8) Meaning of Equal. All written and animated data deemed as *specific* in Level One coding were then coded again based on these Level Two themes.

To analyze data, we built on the aforementioned data analysis with a focus on the specificity of PSTs as they noticed. We took all codes that were general or specific (Level One coding) and the codes of content (Level Two coding) and analyzed the data by examining changes from the written to animated mediums. We analyzed for one of the following four scenarios: General in Writing to General in Animation, General in Writing to Specific in Animation, Specific in Writing to Specific in Animation, or Specific in Writing to General in Animation. We then analyzed for the extent to which the change occurred, meaning the quantity of specific and general comments, such as changing from one specific focus in the written account to two specific foci in the animation (see Table 1). Following this analysis, four of the researchers discussed major themes across the data set. This information resulted in discussion about: (a) the type of change that occurred (i.e. specific to general), and (b) the content of the change each ultimately informing the role animation played in replacing, adding, transforming or hindering PST noticing.

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Table 1: Codes for Level of Specificity in Communication

Code Number	Change Description	Animation Content Compared with Written Content. Animation has…
Code 1	Specific to Specific	Same Content
Code 2	General to General	Same Content
Code 3	Specific to Specific	Same Content with Additional Specificity
Code 4	Specific to Specific	Specific Content is Different
Code 5	General to Specific	One Specific Focus
Code 6	General to Specific	More than One Specific Focus
Code 7	General to General	Different General Focus
Code 8	Specific to Specific	Different Specific Codes and Written Account had more than one Specific Focus
Code 9	Specific to General	General Stemming from one Specific Focus in Animation
Code 10	General to Specific	Specific stemming from more than one General Code
Code 11	General to Specific	More than one General Code shifted to more than one specific code

Findings

Based on analysis of the written versus animated accounts of PST noticing, four main categories of data were present when comparing PSTs' levels of specificity: general to general, general to specific, specific to specific, and specific to general. We describe the change with respect to specificity from the written account to the animated account, both intended to capture the salient moment of PST noticing. Figure 3 shows the distribution of the categories of change for the PSTs.

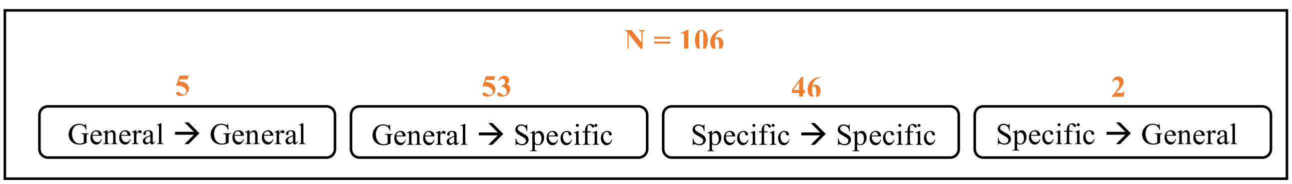

Figure 3. Distribution of change from written to animated noticing based on degree of specificity.

Chi-Square for type of change was 80.94 (df=3, $p < .001$). Therefore, changes from the written to animated noticings towards general occurred less than expected by chance, and moves toward specific occurred more than expected by chance. The two main categories that occurred more than expected by chance and represented the greatest number of PSTs were general to specific (n=53) and specific to specific (n=46). Consequently, we focus our results on these two categories because they represent the greatest number of PSTs and are statistically distinguished from the other two categories.

Following analysis of the overall categories, we analyzed additional details about the changes that were occurring across mediums to further recognize how PSTs were expressing their noticing both through the written and animated mediums. For example, Code 10 states, "Two general to one specific" this indicates that in the written record of noticing, the data from the PST in this category had two general topics that were present and when the PST animated, the animation had one specific topic included (see Table 1). Similarly, as another example, in data coded with Code 4, the PSTs' written data were each coded with one specific code and when they animated, they focused on a different specific code.

After recognizing the various paths taken by the PSTs, we sought understanding for the changes that occurred from the written to animated mediums that would provide insight to mathematics teacher educators about how PSTs' thinking was communicated differently across the two mediums.

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The most common scenarios for PSTs who transitioned from written general accounts to specifics in their animations were to transition from one general aspect in the written noticing to one specific focus in the animated noticing (code 5, n=29) or to transition from one general aspect to more than one specific focus when animating (code 6, n=20). Analysis of those who were specific in their written accounts and maintained specificity in their animations showed that it was common for PSTs to write about one specific topic and then animate that same aspect (code 1, n=18). Additionally, many PSTs began with one specific focus and then animated that topic along with at least one more specific topic (code 3, n=11). There were also PSTs who wrote about one specific topic and then animated a different specific topic (code 4, n=16). These five cases were further distinguished in the data set because they represented the majority of the PSTs and posed interesting situations about how the PSTs were maintaining or adjusting their noticing with the use of different mediums.

General to Specific Noticing Across Mediums

The PSTs who had general descriptions of what was noticed in their written analysis and then included a specific connection between the teacher or student and another person or aspect in the animation accounted for 49 of the 106 cases, being the most common change noted across the data set. Within these cases, 29 PSTs shifted their noticing to one specific aspect while 20 focused on two or more aspects in their animation.

One general to one specific. There were 29 PSTs who focused on one general aspect in their written account and one specific aspect in their animation. As the shift from general to specific occurred, two main features were identified. First, most PSTs introduced additional people into the animation who were not mentioned in the written account of noticing. For example, one PST focused on students when describing her pivotal moment in writing, "When the student expressed that everyone (all 8 people) will have the same amount of cookies and none left over." When the same PST animated the pivotal moment (see animation at https://youtu.be/ZUGf1x8FOkQ), she included the teacher and had the teacher prompt a student (named Grinch) to explain an equal sharing problem and justify his thinking. As seen in this example, a shift from a general account in the written medium typically involved the addition of other people in the animated medium. Second, as the PSTs shifted from a general focus in their written accounts to specific connections in their animations they increased the frequency comments related to mathematics. In the animations, the PSTs most notably included fair sharing, the explanation of a method, or the meaning of equal or equal parts.

One general to more than one specific. There were 20 PSTs who focused on multiple aspects within their animations. Nineteen of the 20 PSTs focused on the use of justification or explanation as one of their paired aspects which was often not noted in the written noticing across these cases. For example, one student wrote, "I chose the moment when the teacher asked the students if ½ a cookie would work." In the animation of this moment, the PST connected this action to the notion of student explanation or justification. The second theme among these 20 PSTs was the specific use of justification or explanation to support student mathematical understanding of fair share within the animated video. This occurred in 80% of the cases. The final theme across these cases was the use of *anchor* questions within animations to support the PST noticing. A majority of the students had the teacher asking questions such as, "How do you know you are right? What did you come up with? What did you guys do?" These questions served as an entry point and focus of conversation within the animated video, but were rarely mentioned in the written reflection.

Analysis across all 49 cases of PSTs who wrote about general aspects and animated specific aspects indicates: (a) an increased quantity of people present, (b) an increased mathematical focus, especially with fair sharing, (c) the inclusion of explanation and justification, and (d) the inclusion of anchor questions embedded in dialogue in their animations. These findings indicate that when the PSTs animated their noticings, they were more specific and included elements of effective mathematics teaching and learning that were not present in their written accounts.

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Discussion and Implications

We argue that the practice of implementing the animation platform as a mechanism for PSTs to communicate their noticing was transformative (Hughes et al., 2006) because the medium afforded opportunities for PSTs to convey their thoughts about classroom interactions in a way that was not afforded through the written medium alone. We support this claim with the increased specificity that was apparent in the animations as compared to the written records. Further, we consider this practice of animating, as a transformational experience, to serve as an approximation of practice for teaching; the transformational features of the animation enabled PSTs to engage in approximating actual teaching practice (Grossman et al., 2009).

According to Grossman et al. (2009) approximations of practice engage participants in practices that are proximal to the practices of a profession, meaning closely related to teaching in this case. As previously mentioned, current research has examined approximations of practice in multiple forms, including through technological mediums and other avenues (e.g. Herbst et al., 2014). In fact, Herbst et al. (2014) focused on media rich, web-authoring tools for PSTs to create scenarios as an approximation of practice. We argue that our use of animation provides similar opportunities for approximating teaching as does their platform, *LessonSketch*. The ability to manipulate audio and visual components of figures (i.e. student(s) and teacher) in a scene in the present study further increases the opportunities for proximal practice through transformational means. More specifically, when considered in combination with the literature on professional noticing, this medium afforded opportunities for PSTs to approximate their practice as they communicated what they professionally noticed.

Further, in the present study, animation was used in the context of a mathematics methods course. We recognize the affordances of this medium for providing PSTs with opportunities to communicate their noticing about a mathematics scenario. However, future research should examine how the platform could be used in other disciplines and contexts to provide proximal practices that closely mirror actual teaching (Grossman et al., 2009). These opportunities are essential for teacher development because they provide opportunities for deliberate practice, allow for elaborations of practice, and highlight PST considerations about the profession—all key components for learning to teach.

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