REPRESENTATIONS OF ALGEBRA INSTRUCTION IN PRESERVICE TEACHER EDUCATION

Jillian N. Wilsey
University at Buffalo, The State University of New York
jdeverin@buffalo.edu

Deborah A. Moore-Russo
University at Buffalo, The State University of New York
dam29@buffalo.edu

This study examined preservice teachers' reactions to and reflections on a set of five animations as representations of algebra instruction. The results showed that most comments in the preservice teachers' reflections were related to: (a) student learning and motivation, or (b) the classroom and instructional environment. Few comments in the reflections focused on the preservice teachers' reactions to the realistic nature of the animations. The data suggest that animations are a useful alternative to video. Not only do they allow for a condensed format that is free of distractions and focuses on a specific scenario to be analyzed, this study suggests that animations can also promote productive reflection without prior scaffolding.

Keywords: Teacher Education–Preservice

Purpose of the Study

This study examined preservice teachers' reactions to and reflections on animations as representations of algebra instruction. It revolved around the implementation of animations with preservice teachers in a methods course and focused on their responses to the classroom dynamics portrayed in the animations. Since animations are a relatively new medium to represent classroom instruction, we explored preservice teachers' reactions to the animations themselves as well as the extent and quality of the preservice teachers' discussions relative to what they noticed in the animations. More specifically, this study addressed the following research question: What are preservice teachers prompted to discuss after viewing the animations when implemented without prior prompts or scaffolding?

Theoretical Framework

Star and Strickland (2008) define noticing as what preservice teachers identify and deem important or noteworthy when viewing a classroom scenario. Santagata and Guarino (2011) identify what they consider "fundamental skills for reflecting and learning from teaching" as "the ability: (a) to attend to important elements of instruction, (b) to reason about these elements in integrated ways, and (c) to propose alternative instructional strategies" (p. 134). While noticing is important, preservice teachers must also be able to reflect on what they have noticed before they are able to apply what has been observed.

Providing representations of classroom scenarios prompts preservice teachers to consider and discuss the dynamics portrayed thus helping to bridge theory with practice (Harrington & Garrison, 1992). Video is commonly utilized to provide these representations along with guidance from provided prompts or scaffolding to facilitate what is noticed and reflected upon. However, Stockero (2008) points out that preservice teachers "need to move away from a dependence on external prompting if they are to continue to ground their analyses in evidence after a university course is over" (p. 377).

While videos have been a common medium in teacher education, animations are relatively new but provide unique benefits. Although animations represent practice, they are scripted in a manner that allows for a condensed format in terms of both focus and duration. Animations, because they are manufactured representations of instruction, can be pared down to specifically what one wants the viewer to consider in a time-efficient manner. This reduction in complexity removes many of the distractions that naturally accompany video. In fact, Moore-Russo and Viglietti (2011) found in their study of teachers' reflections on animations of geometry instruction that the lack of complexity did not impact the preservice teachers' impressions of the animations as realistic representations of teaching.

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Methodology

Participants

Data for this study came from two groups of preservice teachers enrolled in a methods course for secondary mathematics teachers in the fall 2010 and fall 2011 semesters at a large research university in the northeastern United States. All of the preservice teachers held mathematics degrees and were enrolled in a certification program through a graduate school of education. The fall 2010 group of preservice teachers consisted of five females and three males. The fall 2011 group of preservice teachers consisted of four females and four males. Five of the eight preservice teachers in the fall 2010 section and six of the eight preservice teachers in the fall 2011 section were concurrently enrolled in their field observation components.

Setting

The methods course is a three-credit hour, graduate-level course with a primary goal of preparing those with mathematics degrees to be secondary school mathematics teachers. This course is designed to address the aspects of pedagogical content knowledge including: knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum (Ball, Thames & Phelps, 2008). The course covers a variety of topics including classroom management, lesson planning, and implications of educational theories (e.g., social constructivism) on the practice of teaching. There is a particular emphasis on the National Council of Teachers of Mathematics' (NCTM's) (2000) vision for mathematics education.

About half way through each semester, the preservice teachers were assigned to view five animations over a period of five weeks, one per week. The instructional intentions were to use the animations as a common reference for collaborative reflection, discussion, and analysis. They provided an opportunity for teachers to engage in reflective discourse grounded in a shared experience, one that represented different secondary algebra classrooms.

The animations used cartoon figures to represent episodes of instruction in various secondary algebra classrooms. The cartoon figures were each colored, and their names corresponded to their colors. For example, one student was Blue, another was Red. All cartoon characters were gender neutral.

Since the preservice teachers were not able to go as a group to observe a classroom, the animations served as condensed, "shared" experiences for the methods class. The animations were from ThEMaT (Thought Experiments in Mathematics Teaching), an NSF-funded program at the University of Maryland, which has developed animations as representations of classroom scenarios to be used in teacher education (for more information on the animations representing algebra instruction that were used, go to http://www.education.umd.edu/MathEd/ThEMaT.html).

The animations were chosen as representations of teaching for two reasons. First, they portrayed secondary classroom instruction—all from different classrooms with different teachers (as noted by the varying voices used for the teachers in the animations). Second, they have been found to be effective in eliciting discussion among experienced teachers often compelling them to project themselves into the stories (Herbst & Chazan, 2006).

Data Collection and Analysis

After viewing each animation, the preservice teachers were required to make three entries (two in response to classmates) to an asynchronous, electronic discussion forum over the course of a week as a part of their homework assignment. The instructor did not contribute to the online discussion boards nor was any feedback to the entries provided. Students were informed that they were to be graded on their entries, considering both the content of their entries and the personal knowledge growth evidenced from the entries over the course of the semester.

Inductive content analysis was used to identify the themes emerging from the discussion board data. This consisted of multiple readings followed by the recording of each researcher's thoughts utilizing theoretical memoing (Glaser, 1998). Once this stage was completed, the researchers revisited the

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discussion board entries jointly and compared their memos, forming categories. The researchers noted that most notions raised in the memos were mentioned by both researchers and often on more than one animation.

The researchers jointly revisited each animation in light of the identified categories until it was clear that all ideas in the entries would be able to be coded. The research team then jointly conducted a "horizontal" pass through the discussion boards agreeing on themes that emerged from the categories that ran across all five animations. After this, the researchers then independently coded all 248 of the preservice teachers' discussion board entries. Each individual discussion board entry served as the unit of analysis. Each unit of analysis was assigned as many codes as were deemed applicable. The overall percentage of agreement for coding was above 90% for both 2010 and 2011 sets of data. The Cohen's kappa values were at or above 0.80 for each data set, well above the generally accepted 0.60, which represents good agreement (Landis & Koch, 1977; Altman, 1991). The two independent coders reached consensus by means of discussion for each entry that had been assigned a different code. The research team began analysis at this stage.

Results

During the analysis, several themes evolved from the discussion forums. In reviewing and coding the discussion board entries over five animations and two methods courses, six recurrent themes were identified: (a) *supporting student learning and motivation*, (b*) classroom and instructional environment*, (c) *mathematics in the animations*, (d) *reflections on past observations and one's own future practices*, (e) *reality of the classroom*, and (f) *reactions to the animations*.

Table 1 presents the frequency of comments relating to each identified theme, along with the percentage, or relative frequency, for each category. Examining the compiled data, the greatest amount of time was spent in discussing *supporting student learning and motivation* while the least amount of time was spent in discussing the *reactions to the animations*. The *supporting student learning and motivation* theme included categories focused on student learning such as understanding as the goal of instruction, providing positive feedback for students' efforts, building on what the students know, responding to students' questions, and preventing or correcting student misconceptions.

Table 1: Presence of Themes in Discussion Forum

Theme	Frequency	Relative Frequency
Supporting Student Learning and Motivation	461	42
Classroom and Instructional Environment	303	27
Mathematics in the Animations	168	15
Reflections on Past Observations and One's Own Future Practices	81	7
Reality of the Classroom	59	5
Reactions to the Animations	39	4

The theme with the second highest frequency of comments was the *classroom and instructional environment* theme. This theme contained categories that were concerned with the teachers' instructional obligations, preparedness and flexibility, attitude, and the classroom environment in general. Comments in this theme were often related to what a teacher should do such as support and explain ideas presented and provide more direct instruction when it is clear that guiding is not productive. Comments also captured the nature of the classroom environment as one that should be safe and respectful where students are not afraid to ask questions.

The *mathematics in the animations* theme included comments revolving around the mathematics presented in the animations and the use of technology such as calculators. This theme also captured the multiplicity of mathematics in that mathematical concepts can often be represented or considered in

multiple ways and often there is more than one solution method that may be applied when solving a problem.

The final three themes that presented were not as frequently noted. The *reality of the classroom* theme focused on the challenges faced in the classroom environment such as time constraints and pressure to cover a certain amount of material or to cover it in a certain way in order to satisfy state assessment requirements. Comments in this theme also addressed the fact that not all students will perform optimally and give forth their best efforts. The *reflections on past observations and one's own future practices* theme included comments that related to individual preservice teachers' reflections on what they believe they will encounter in their classroom and the decisions they may make in response. This theme also included categories that captured the preservice teachers' reflections that compare what was presented in the animation to what they experienced throughout their academic career and in their field observations. The *reactions to the animations* theme captured comments and discussion that focused solely on the nature of the animations themselves, such as comments related to the depiction of the characters in the animations or to the animations as a particular snapshot in time where the viewer does not know what came before or transpired after that featured episode.

Discussion

The data show that the preservice teachers were most likely to post entries on the discussion boards that fell under the *supporting student learning and motivation* theme. This theme had 13 categories; the most frequently evidenced category related to *understanding* as the goal of instruction and issues around promoting deeper student thinking. The *understanding* category represented 21% of the comments under this theme. The following entries exemplify the comments made by the preservice teachers that were assigned to the *understanding* category:

> *The teacher asked a lot of questions to see where the students understanding was, and [did] not move on until they all showed understanding*.

> *The students that have to explain it are forced to have a complete understanding of the material … This shows a class that is much more focused on a conceptual understanding of what is going on than a simple procedure*.

The second most prominent category was *constructivism*, which was assigned to 16% of the comments under the *supporting student learning and motivation* theme. Comments that mentioned building on what the students know and allowing students' ideas to guide the direction of instruction were assigned to this category. The following entries exemplify the comments made by the preservice teachers under the *constructivism* category:

> *I loved the way that the teacher was able to step back and allow the students to explain their solutions and their reasoning*.

> *I think "tricking" the students into thinking that they are coming up with all of the work is a pretty good strategy to use. In reality, they are actually coming up with most of the work*.

Other categories under the *supporting student learning and motivation* theme also were evidenced in 10% or more of the preservice teachers' comments. The *affective concerns* category, which was assigned comments related to providing positive feedback to students and acknowledging their efforts, represented 13% of the comments under this theme. The *responding to students' questions* and the *addressing student misconceptions* categories each represented 10% of the comments under this theme. The following entries exemplify the comments made by the preservice teachers under the *affective concerns* and *addressing student misconceptions* categories, respectively:

> *Showing them that we care will give them more confidence and make them more successful math students*.

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Common mistakes, such as when half of the class gets the same wrong answer, need to be addressed, and correct answers need to be shown.

The prominence of comments assigned to these categories provide evidence that even without direct, prior prompting or scaffolding, the preservice teachers were able to view the animations with a student-centered focus.

The theme that ranked in second place in terms of the number of discussion board entries assigned to categories under it was *classroom and instructional environment*. Under this theme, many comments made it clear that even though the preservice teachers were student-focused, they also were concerned with the teacher's role in the classroom. This theme had nine categories. The most frequently evidenced category related to *teachers' instructional obligations*, which included such things as providing clear, direct explanations. This category represented 21% of the comments under the *classroom and instructional environment* theme. The following entries exemplify the comments under this category:

[T]he teacher simply explains that "it isn't appropriate to use [negation] here" and that "time can't be negative anyway." Her first comment is vague at best and does not help the students.

I felt the teacher was ineffective in their [sic] explanation…nothing was being summarized.

The preservice teachers also posted a number of discussion board entries regarding how: (a) the material was presented, including the pace of the instruction and how the board and other resources are used in instruction (16%); (b) how teachers need to be prepared with the necessary knowledge of content and pedagogy that allows them to have flexibility in their teaching (16%); and (c) how the classroom environment should be a safe and respectful one where students are encouraged to ask questions and share (15%). The following three entries exemplify the comments under *instructional presentation*, *instructor's preparedness and flexibility*, and *safe/respectful environment* categories, respectively:

I really liked the use of the balance as an analogy for solving the problem. Many people talk about viewing an algebraic equation as a scale, but I liked how this teacher actually drew out a scale… It gave the equation a very tangible representation.

… the teacher seemed like the type of teacher who is comfortable with one way to solve a problem [who] does not want to open up to the possibilities of other correct options. He is not confident in his understanding of the other ways of looking at the problem…

I believe that it is all about creating an environment in your class where it is okay to be wrong… if I can get as many students as possible to feel comfortable doing this, the better my classroom will be.

The theme with the third highest frequency was the *mathematics in the animations* theme. While all five of the animations focused on the mathematics inherent in a secondary algebra classroom, the greatest amount (42%) of entries under this theme were assigned to the *multiplicity of mathematics* category. Under this category, preservice teachers' comments frequently dealt with how there are multiple solution methods available for any given mathematical problem and that most, if not all, mathematical concepts may be thought of in multiple ways. The *mathematics in the animations* theme only had two other categories: the *general mathematics* category, which contained general comments about the mathematics in the animations, and the *technology in mathematics* category, which included comments about the use of technology as a tool to help solve mathematical problems or represent mathematical concepts. These categories held 40% and 18%, respectively, of the comments under the *mathematics in the animations* theme. Almost all of the entries assigned to the *technology in mathematics* category were for the fourth animation, which specifically dealt with the utilization of a graphing calculator. The following entries exemplify the comments made by the preservice teachers under the *multiplicity of mathematics* and *technology in mathematics* categories, respectively:

… although some students approached the problem differently all of the methods are correct and completely acceptable so its ok to choose the approach that makes the most sense to you as an individual …

I think it is interesting though, how they were supposed to be doing it on the calculator. We include these technologies in classrooms so that students can get experience using the tools they will have in the workplace.

Reflections on past observations and one's own future practices was the fourth most common theme. Although some of the preservice teachers reflected on their own academic careers as students, most of the entries that were coded under this theme (44%) related to the *future-oriented reflections* category where the preservice teachers pondered what it would be like in their own classrooms and how they would handle situations that arose. The *reflections on past observations and one's own future practices* theme contained two other categories: the *past observations* category, which contained comments that made comparisons between the events in the animation and the preservice teacher's experiences as a student or in field observations, and the *other sources* category, which included comments revolving around comparisons between the animations and what the preservice teachers had been exposed to in courses, readings, and outside educational resources. These categories held 33% and 22%, respectively, of the comments assigned to the *reflections on past observations and one's own future practices* theme. The following entry exemplifies the comments made by the preservice teachers under the *future-oriented reflections* category:

I have always wonder [sic] how and what I should do with students who miss class, do I cross my fingers and hope they can just catch on and move along with the class? Or should I take them aside and help them learn the material they have missed?

The theme with the fifth highest frequency was the *reality of the classroom* theme. This theme also had only three categories. The most frequently evidenced category related to *students are different*, which included such things as recognizing that students often think about things differently and learn differently. Thus, teachers need to be aware that differentiated instruction may be required in order to satisfy the needs of all students. This category represented 46% of the comments under this theme. Other preservice teachers' comments often related to time constraints in the classroom and pressure to cover a certain amount of material or pressure to cover the material in a certain way to satisfy state assessments. This category, *pressure and constraints*, represented 42% of the comments under the *reality of the classroom* theme. The remaining category, *students do not perform optimally*, included such things as students' inability to recall information, minimal student effort, and poor student attitudes. This category represented 12% of the comments under this theme. The following entry exemplifies the comments made by the preservice teachers assigned to the *students are different* category:

There was [sic] definitely different levels of learners in this class, as well as different styles of learners.

Finally, the last theme contained entries that addressed the preservice teachers' *reactions to the animations*. The *animations as snapshots* category represented 38% of the comments under this theme. This category contained comments related to the realization that what transpired before or after the particular episode could have impacted the teacher's actions. By not having knowledge of prior or subsequent events, the preservice teachers recognized that their interpretation of the teacher's actions in the animations could be inaccurate. The *reactions to the animations* theme contained three other categories. The *characters in animation* category contained comments related to the depiction of the cartoon characters in the animations, in particular that the characters were identified without the use of gender, ethnicity, etc., and represented 31% of the comments under this theme. The remaining two categories were the *verifying reality of animations* category which suggested that the animations reflected what actually occurs in classrooms and the *questioning reality of animations* category which suggested that the animations do not reflect what actually occurs in classrooms. These categories held 26% and 5%, respectively, of the comments assigned to the *reactions to the animations* theme. The following entry exemplifies the comments made by the preservice teachers under the *animations as snapshots* category:

I'm not saying this is necessarily what I think, but there's a world of information not presented to us while watching a 2:49 clip.

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In light of the fact that the *reactions to the animations* theme presented the least amount of comments overall, this provides evidence that the preservice teachers seemed to think that the animations were reasonable representations of teaching, which corresponds with Moore-Russo and Viglietti's (2011) study findings.

Overall, animations are a useful alternative both to group classroom observations and to video. While reducing the complexity of the classroom, they still provide a sense of the temporality of events and represent the dynamic, often ill-structured, nature of classroom instruction in a time-efficient manner. They focus on what teacher educators might want preservice teachers to notice, reflect upon, and discuss with their peers. In summary, this study suggests that unlike videos where research suggests that guidance is needed to direct preservice teachers' focus to particular events for analysis (Santagata & Angelici, 2010), animations seem not to need instructor scaffolding in order for preservice teachers to be able to productively notice and reflect on the presented classroom instruction.

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