Educating Pre-Service Teachers on Effective Diagnosis and Correction of Math Errors Using Technology

Danilo M. Baylen
dbaylen@westga.edu

V. Michelle Michael
vmichae1@my.westga.edu

Rosalind Duplechain
rduplech@westga.edu

University of West Georgia
Carrollton, GA
United States

Abstract: A design and development study was funded to create a group of supplemental technology-based tools to support the enhancement of pre-service teachers' knowledge and skills in diagnosing and correcting mathematical errors of children in PK-5 classes. This exploratory and descriptive study focused on answering the question, "How helpful are these technology-based tools in supporting the pre-service teachers' ability to diagnose and correct mathematical errors?" Data was collected from online surveys completed by twenty-four pre-service teachers who reviewed nine video clips of a teacher working with a young learner in completing simple math problems. Findings of the study reported that the participants found the video clips helpful in their professional development, and served as a reference point for reflective practice. Participants stated that the online availability of videos allowed ease of access, and created opportunities for reflection. The study showed that the integration of supplementary technology-based tools added visual and auditory features to the learning experience.

Introduction

Teaching mathematics education to pre-service teachers is not an easy task. Learning to teach mathematics requires focus and competence on the part of pre-service teachers. Further, learning to assess and correct mathematical errors while teaching young children can be challenging. Mastering the art of diagnosing and correcting mathematical errors necessitates extensive hours of learning and practice.

This initial and exploratory study provided an opportunity to understand how pre-service teachers (as participants) work with supplementary technology-based tools as they learn how to diagnose and remediate mathematical errors in young learners. Researchers

wanted to know how the participants found these tools helpful in identifying and correcting errors, and challenging to use to as part of their professional development.

Literature Review

Integration of technology in education is considered fundamental in present-day learning. However, this cannot be attained without the teachers being familiar with the technology and integrating them in their classroom teaching (Jones & McLean, 2012). It is undeniable that the use of video in the classroom is one of the ways of integrating technology and multimedia. According to Friel and Carboni (2000), "[T]here is potential for video-based pedagogy to provide alternative experiences that may stimulate reflection and reconstruction of beliefs on the part of the pre-service teachers, moving from a didactic to a more student-centered pedagogy" (p. 124-125). Video-based teaching expands student awareness by forming an atmosphere appropriate for practical learning.

Currently, teaching mathematics as well as the techniques of identifying and correcting mathematical errors to pre-service teachers is eased by the incorporation of technology. Niess (2006) stated, "To be prepared to teach mathematics then, teachers need an in-depth understanding of mathematics (the content), teaching and learning (the pedagogy), and technology…, they need an integrated knowledge of these different knowledge domains, the overlap and integration of these domains" (p. 196). Using technology in classroom supports and facilitates easy identification and correction of mathematical errors.

Star and Strickland (2008) report that watching videos and conducting short group discussions act as a tool that encourages dialogue to recognize challenges in learning and teaching. While videos and the use of multimedia in the classroom might not be the only solution for better understanding of content and improved comprehension, it certainly acts as a complementary tool that aids to comprehend the subject at hand. Santagata, Zannoni and Stigler (2007) reported, "Videos of classroom instruction make it possible to connect the knowledge teachers are learning in their pre-service teacher education courses to the classroom context in which they will one day apply that knowledge" (p. 125).

Finally, Larkin-Hein & Zollman (2000) argue, "[V]ideo can be used to link current mental representations of concepts to real world situations in a way that learners with little prior knowledge may have trouble accomplishing on their own" (p. 19). Understanding the importance of technology-based pedagogy, this study was conducted to assess the benefits of video-assisted teaching in enhancing pre-service teachers' abilities to identify and correct mathematical errors among young learners.

Research Questions

This exploratory and descriptive study involved a group of pre-service teachers who were shown nine video clips. The researchers wanted to know how they find the supplementary technology-based tools in terms of helping them diagnose and resolve mathematical errors. Also, the researchers would like to know how these tools helped the

participants in their assigned tasks as well as identify the challenges they experienced while accessing them. This study proposed two research questions:

1. How helpful are these supplementary technology-enhanced tools to the pre-service teachers' understanding of course content (the diagnosing and correcting of mathematical errors)?
2. In what ways are these supplementary technology-enhanced tools helpful to their understanding of course content?

Context

A group of pre-service teachers are enrolled in a course on how to teach mathematics to young learners. During the course of study, the pre-service teachers were introduced to supplementary technology-enhanced tools (i.e., nine video clips) of a teacher working with a young learner on simple mathematical problems available online. The objective of each video clip is to demonstrate the process of identifying and correcting mathematical errors. After watching each video clip, the pre-service teachers were asked to complete an online feedback form about the video they saw with questions asking about its helpfulness, usefulness and ability to motivate to do the task correctly.

The nine video clips were created as supplementary digital resources to support learning how to identify and correct mathematical errors. Pre-data collection, analyzing the data, making a pre-diagnosis, interview and the final diagnosis were specified as the steps for diagnosing math problems. In addition, the video clips were given a brief title and explanation which covered the following areas:

A. After a brief introduction and statement of purpose, the teacher asks the learner to complete a worksheet of math problems.
B. The teacher uses flash cards to collect more data about the learner's math knowledge and skills (basic facts). Based on the learner's responses, the teacher organizes the flash cards in three piles (the teacher counts up to three seconds to determine the appropriate pile for each flash card).
C. Teacher uses the piles to complete a Basic Facts Card as part of the diagnosis. (Viewers are asked to focus on the basic facts that are not mastered).
D. Teacher interviews the learner about her disposition to math and math abilities, any supports she has in and out of the classroom, and her strategies for memorizing information.
E. Teacher asks the learner to complete several math problems. This time, the learner is asked to think loud as she completes each problem.
F. Teacher asks the learner to create a visual representation of the math problems presented to her.
G. Teacher uses a game to teach a number strategy to the learner.
H. Teacher uses manipulatives to engage learner in solving math problems, starting with basic facts.
I. Teacher uses manipulatives to further engage the learner in solving math problems by continuing with the multiplication of a two-digit number by a single digit number.

Participants

The sample population for this study was thirty students enrolled in an undergraduate course identified as ECED 4251 Assessment and Correction: Mathematics Education, in spring 2014 at a comprehensive university in southeastern United States. However, only twenty-four students volunteered to participate and complete all the required surveys and feedback forms. The sample population as pre-service teachers majored mostly in early childhood and elementary. There were two males and twenty-eight females.

Data Collection Strategies

The participating pre-service teachers were asked to complete a short survey after watching each video clip which included the following statements:

1. The video clip I watched or visited was HELPFUL in learning how to diagnose or correct math errors.
2. The video clip I watched or visited was USEFUL in learning how to diagnose or correct math errors.
3. The video clip I watched or visited MOTIVATED me to do a better job in diagnosing or correcting math errors.

The key words in each statement were capitalized for emphasis. The word "Helpful" implied how the videos helped them to understand the content of the subject while "Useful" and "Motivated" suggested how the learning from the videos could be used or implemented in their educational practice as teachers of mathematics, and how the videos motivated them to improve their current skill level when diagnosing and correcting mathematical errors, respectively. For each of the above statements, the pre-service teachers were asked to make a response based on the following scale: Strongly Disagree, Disagree, Unsure, Agree, and Strongly Agree.

In addition to each short survey following the nine video clips, they were also asked to complete an Overall Feedback Form after watching all video clips. Data collected generated both quantitative and qualitative information. The overall feedback form contained two statements similar to the previous short surveys on an agreement/disagreement scale:

- The collection of 9 video clips I watched or visited was HELPFUL in learning how to diagnose or correct math errors.
- The collection of 9 video clips I watched or visited was USEFUL in learning how to diagnose or correct math errors.

In addition, the participants were asked to complete two sentences for which they had to share their personal experience from this exploratory and descriptive study:

- Please complete this sentence—this collection of 9 video clips I watched or visited was HELPFUL because…
- Please complete this sentence—this collection of 9 video clips I watched or visited was USEFUL because…

Finally, a question about the challenges encountered and any future changes they would like to see in this exploratory and descriptive study was asked:

- What changes would you like to see in order to improve the value of this collection of video clips to those learning how to diagnose and correct math errors?

The open ended questions which "provide[s] useful insight into a topic" (Kelley, Clark, Brown, & Sitzia, 2003) fulfilled its purpose in this survey by helping the researchers analyze what the pre-service teachers personally gained through the video clips and the recurring patterns that emerged throughout their answers.

Results

The survey results showed that most of the pre-service teachers agreed on the benefits of integrating video clips, as supplementary technology-based tools, in learning to diagnose and correct mathematical errors.

Helpfulness

The first survey question asked the participants to respond on the helpfulness of each video clip to their practice. On the average, almost 46% of the participants responded that they strongly agree on the helpfulness of each video clip. (See Table 1). In addition, more than 46% of the participants responded agreement to the question about helpfulness. This means that participants perceived these video clips to be helpful in their educational practice.

Table 1. Summary of Responses Pertaining to Helpfulness of Video Clip A to I.

Q1	Strongly Disagree (1)		Disagree (2)		Unsure (3)		Agree (4)		Strongly Agree (5)		Total
Form	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*
A1	1	4.2	1	4.2	1	4.2	10	41.7	11	45.8	24
B1	1	4.2	0	0.0	0	0.0	9	37.5	14	58.3	24
C1	0	0.0	0	0.0	2	8.3	13	54.2	9	37.5	24
D1	0	0.0	0	0.0	0	0.0	11	45.8	13	54.2	24
E1	0	0.0	0	0.0	2	8.3	12	50.0	10	41.7	24
F1	0	0.0	0	0.0	2	8.3	11	45.8	11	45.8	24
G1	0	0.0	2	8.3	0	0.0	11	45.8	11	45.8	24
H1	0	0.0	0	0.0	2	8.3	11	45.8	11	45.8	24
I1	0	0.0	1	4.2	2	8.3	12	50.0	9	37.5	24
Average		0.93		1.85		5.07		46.28		45.82	

Note: The *f* refers to frequency counts. Average refers to average of all percentages reported for each scale.

Usefulness

The second question asked participants if they agree that individual video clips were useful to them. On the average, almost 45% of the participants responded that they

strongly agree on the usefulness of each video clip. (See Table 2). In addition, more than 48% of the participants responded agreement to the question about usefulness. Again, this survey results confirm the usefulness of the nine video clips to the participants' educational practices. The total combined percentage of those who agreed and strongly agreed registered at more than 93%.

Table 2. Summary of Responses Pertaining to Usefulness of Video Clip A to I.

Q2	Strongly Disagree (1)		Disagree (2)		Unsure (3)		Agree (4)		Strongly Agree (5)		Total
Form	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*N*
A2	0	0.0	4	16.7	1	4.2	11	45.8	8	33.3	24
B2	1	4.2	0	0.0	0	0.0	8	33.3	15	62.5	24
C2	0	0.0	0	0.0	0	0.0	15	62.5	9	37.5	24
D2	0	0.0	0	0.0	0	0.0	13	54.2	11	45.8	24
E2	0	0.0	0	0.0	1	4.2	12	50.0	11	45.8	24
F2	0	0.0	0	0.0	1	4.2	13	54.2	10	41.7	24
G2	0	0.0	2	8.3	0	0.0	11	45.8	11	45.8	24
H2	0	0.0	0	0.0	2	8.3	8	33.3	14	58.3	24
I2	0	0.0	1	4.2	2	8.3	13	54.2	8	33.3	24
Average		0.47		3.24		3.24		48.14		44.89	

Note: The *f* refers to frequency counts. Average refers to average of all percentages reported for each scale.

Motivational

The researchers wanted to know if watching the video clips was motivating for participants to do better in their assigned tasks. On the average, participants agreed (43.05%) that the video clips motivated them (See Table 3) to do better but a much lower number (37.5) was posted for strongly agree.

Table 3. Summary of Responses Pertaining to Motivational Features of Video Clip A to I.

Q3	Strongly Disagree (1)		Disagree (2)		Unsure (3)		Agree (4)		Strongly Agree (5)		Total
Form	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*N*
A3	1	4.2	1	4.2	4	16.7	12	50.0	6	25.0	24
B3	1	4.2	0	0.0	2	8.3	12	50.0	9	37.5	24
C3	0	0.0	0	0.0	2	8.3	15	62.5	7	29.2	24
D3	0	0.0	1	4.2	0	0.0	11	45.8	12	50.0	24
E3	0	0.0	0	0.0	2	8.3	11	45.8	11	45.8	24
F3	0	0.0	1	4.2	1	4.2	11	45.8	11	45.8	24
G3	0	0.0	1	4.2	2	8.3	12	50.0	9	37.5	24
H3	0	0.0	0	0.0	6	25.0	9	37.5	9	37.5	24
I3	0	0.0	0	0.0	6	25.0	11	45.8	7	29.2	24
Average		0.93		1.87		11.57		43.05		37.5	

Note: The *f* refers to frequency counts. Average refers to average of all percentages reported for each scale.

Overall Project Feedback

In reviewing participants' responses to the four questions on the overall feedback survey, it seems that about half (50%) reported agreement on the helpfulness of the video clips to diagnosing and correcting mathematical errors while 45.8% of the participants reported strong agreement (See Table 4). Further, participants reported a total average of 95.8% as combined percentage of agreement (agree, 62.5% and strongly agreeing, 33.3%) on the usefulness of the video clips to their educational practice.

In the overall feedback, a sentence completion format was used to identify participants' views on how helpful the videos were to them, personally. The data collected illustrated that most of the pre-service teachers found the videos helpful as they brought theories and content from their books to life which aided better understanding of the subject. In Friel and Carboni's (2000) words, "the video episodes made it possible to encounter examples of the topics and issues that were being addressed in the course" (p. 124).

> *"It gave me a glimpse of what I was supposed to do in clinic. I was less confused on the diagnosing and correcting steps. The videos also helped me to see how I should be helping the client overall in clinic."*(S11)
>
> *"It was a great help to see them in real world application rather than just talking about it. It helped me to understand how it works."*(S12)
> *"I was able to see it visually and auditory. It was like a second re-enforcer after class."*(S15)
>
> *"The videos showed how to correctly administer and assess children's mistakes and how to correct them. It was good to see how it is done almost like in person."*(S19)

In the context of the videos' usefulness in their educational practice, the pre-service teachers mentioned that the videos taught them how to professionally handle the clients while teaching them in order to identify and correct mathematical errors.

> *"These videos showed me step by step what I should be doing to correct these certain errors from BF to NBF."*(S05)
>
> *"I was able to see how to use the base ten block to work on the intermediate step of correction with my clinic client. I was able to see what I should do in each step of diagnosing and correcting."*(S11)
>
> *"It was useful because I now have a reference point to look to if I am unsure how to proceed. It also gave me ideas on how to go about teaching students."*(S12)
>
> *"…These videos broke down the process for me in order for me to easily follow the steps."*(S25)

Common themes

Words which referred to see, visualize or show were repeated throughout the survey responses 32 times indicating that the visual aspect of the video clips was an essential component of the study which benefitted the pre-service teachers. According to Berk (2009), videos greatly affect the mind and senses, visually and auditory, intensifying the human emotion through the images, scenes, actors and music. Such emotions are so strong that they leave a lasting memory and make the viewers want to relive the moments which is why we buy DVDs and CDs to watch and recall the memories again. Bringing video clips to the classroom has a similar effect in the minds of the students. This could be a possible reason on why the participants stress on the importance of the visual aspect of these online resources. This is made evident through the words of participants who stated that these resources became a referral point for them to come back and watch exactly what has to be done and how:

> *"I came back and watched the videos multiple times for help."*(S21)

> *"I hope that I will have access to these video clips once I am in my own classroom. They would be a great source to keep for years to come."*(S01)

Challenges

The undergraduate students who participated in this exploratory and descriptive study using video clips as supplementary technology-based tools to support learning on how to diagnose and correct mathematical errors had mostly positive responses. They reported that the experience of accessing and using the video clips advanced their understanding of the subject matter. However, they identified several challenges associated with the conduct of this study.

First, the number of pre-service teachers who participated in the study was smaller than the anticipated number. The researchers were initially informed that there would be a total of sixty students enrolled in the ECED 4251 class and would be eligible to participate in the study. However, half of the expected number of students registered for the course and only twenty-four (24. 80%) fully participated and completed all ten feedback survey forms. The relatively small number of respondents limited the researchers' ability to generalize the conclusions to a wider population of pre-service teachers.

Second, even though several instructions were given on the various ways to access and watch the videos, several participants reported problems in loading the videos because of the web browser or technology platform used. This proved to be a lesson on the importance of giving special attention to technical details and applications in future endeavors.

Moreover, participants expressed their views and in-depth concerns when working with children with special needs or with students who are not as cooperative as the student shown in the videos. Likewise, they also communicated their opinions on the need for additional explanations and examples of the content.

Conclusion

This exploratory and descriptive study on using supplementary technology-based tools (video clips) to support learning has aided the understanding of how an-easy-to-use multimedia tool can be integrated to one's practice to simplify the learning of complex subjects like mathematics for pre-service teachers. The study explored the use and integration of video clips as a teaching tool in enhancing effective learning in diagnosing and correcting mathematical errors with young learners. DeVaney (2009) argued, "[T]he instructional contribution of video presentations may lie in their use as supplemental material. In other words, video presentations may not be the "magical pill" that enhances learning for all students, but they can be one component of an effective instructional design that addresses the different learning styles and needs of students" (p. 607).

This study allowed pre-service teachers to observe an authentic classroom teaching experience, such as, identifying and correcting mathematical errors. The experience gave them an opportunity to access the video clips repeatedly if needed, and at their own convenience. It gave them the time to reflect on the learning from different perspectives unlike live classroom observations which limits the time to watch and learn (Santagata, Zannoni, & Stigler, 2007).

The findings show that this study facilitated the learning experience of these pre-service teachers due to the visual aspect of the technology-based resources used. The accompanying surveys that were completed confirmed the helpfulness, usefulness and motivational features of the video clips to better understand how to diagnose and correct mathematical errors with young learners.

Finally, the outcomes of this exploratory and descriptive study support the argument that visual-oriented artifacts, such as images, illustrations, animations or video demonstrations are important in supporting one's teaching or learning. Visuals are great support in delivering challenging courses, whether delivered face-to-face or online. Out of convenience, one might not include such visual artifacts as they take time to create. However, the return on one's investment of time, in producing these visual resources, can be the difference in one's students' experience towards meaningful learning.

Acknowledgment

The researchers acknowledge the support of the University of West Georgia Institutional STEM Excellence (UWISE) mini-grant program (2013-2014) with funding provided by the Board of Regents STEM II Initiative of University System of Georgia.

References

Berk, R. A. (2009). Multimedia teaching with video clips: TV, movies, YouTube, and mtvU in the college classroom. *International Journal of Technology in Teaching and Learning, 5*(1), 1–21.

DeVaney, T. A. (2009). Impact of video tutorials in an online educational statistics course. *MERLOT Journal of Online Learning and Teaching*, *5*(4), 600-608.

Friel, S. N., & Carboni, L. W. (2000). Using video-based pedagogy in an elementary mathematics methods course. *School Science and Mathematics*, *100*(3), 118-127.

Jones, M. M., & McLean, K. J. (2012). Personalising learning in teacher education through the use of technology. *Australian Journal of Teacher Education*, *37*(1), 74-92.

Kelley, K., Clark, B., Brown, V., & Sitzia, J. (2003). Methodology matters: Good practice in the conduct and reporting of survey research. *International Journal for Quality in Health Care*, *15*(3), 261-266.

Larkin Hein, T., & Zollman, D. A. (2000). Digital video, learning styles, and student understanding of kinematics graphs. *Journal of STEM Education*, *1*(2), 17-30.

Niess, M.L. (2006). Guest editorial: Preparing teachers to teach mathematics with technology. *Contemporary Issues in Technology and Teacher Education, 6*(2), 195-203. AACE.

Santagata, R., Zannoni, C., & Stigler, J. W. (2007). The role of lesson analysis in pre-service teacher education: An empirical investigation of teacher learning from a virtual video-based field experience. *Journal of Mathematics Teacher Education*, *10*(2), 123-140.

Star, J. R., & Strickland, S. K. (2008). Learning to observe: Using video to improve pre-service mathematics teachers' ability to notice. *Journal of Mathematics Teacher Education*, *11*(2), 107-125.