2019

Learning Productive Mathematical Talk Moves Through Mix-Reality Simulation: The Case of Pre-service Elementary Teachers in a Hispanic Serving Institution

Jair J. Aguilar
The University of Texas Rio Grande Valley

James A. Telese
The University of Texas Rio Grande Valley

Learning Productive Mathematical Talk Moves Through Mix-Reality Simulation: The Case of Pre-service Elementary Teachers in a Hispanic Serving Institution.

Jair Aguilar and James A. Telese
The University of Texas Rio Grande Valley
United States
jair.aguilar@utrgv.edu
james.telese@utrgv.edu

Abstract: Teacher preparation programs require pre-service teachers to engage in field experiences that include participation in classrooms (Freeman, 2010). Mix-Reality Simulation (MRS) is a technological tool that can be implemented to provide pre-service teachers opportunities to develop pedagogical techniques such as providing feedback, conducting discussions, integrating technology with instruction while at the same time exploring different environments (Hixon & So, 2009). This paper presents preliminary results of a first-stage research in the implementation of a MRSs' into an elementary teacher education program at a large Hispanic-Serving Institution. The purpose of the study was to determine whether differences existed between the groups in eliciting student's mathematical understanding through the use of productive mathematical talk-moves (Chapin, O'Connor, & Anderson, 2009). Preliminary analysis show that the pre-service teachers exposed to MRS felt more confident in conducting formative assessment of students through questioning and clinical interviews, than their peers not exposed to the Intervention.

Key words: Mixed-Reality, Pre-service-Teachers, Talk-moves, discourse.

Introduction

There is a large number of schools that are in need of high-quality, well-prepared teachers, especially for schools that serve a high minority, a high poverty student population, or one with a large number of low performing students (Weber, 2017, p. 21). A debate exists concerning the quality of both traditionally prepared teachers and alternatively prepared teachers (Darling-Hammond, Chung, & Frelow, 2002). Many alternatively prepared teachers do not experience elements of a traditional teacher education preparation program such as, focused and relevant field experiences. Researchers who study field experiences have shown that they positively promote growth of pedagogical content knowledge and is a necessary and beneficial aspect for teacher preparation (Everling, Delello, Dykes, Neel, & Hansen, 2015).

Typically, traditional teacher preparation programs require pre-service teachers to engage in early field experiences in which they complete field observation hours (Freeman, 2010). These early field experiences introduce pre-service teachers to the school's context, classroom situations, and students. Technology can be implemented as part of the preparation program as a way to enhance teacher's preparation (Peterson-Ahmad, 2018), and to provide them opportunities to engage in experiences that model actual classroom events, like the ones offered by mixed-reality simulations [MRS] (Lindgren, Tscholl, Wang, & Johnson, 2016).

MRSs software such as, TLE TeachLive™/Mursion™ (Andreasen & Haciomeroglu, 2009) has many advantages including providing preservice teachers opportunities to practice various instructional strategies in a variety environments, developing skills in providing feedback, integrating technology, and practicing teaching content related concepts (Hixon & So, 2009). Furthermore, MRSs allow pre-service teachers to develop in a safe environment, classroom discussion and diagnostic skills (Hoth et al, 2016) that elicit student's thinking regarding mathematics understandings (Hatton, Birchfield, & Megowan-Romanowicz, 2008). Straub, Dieker, Hynes, & Huges, (2014) conducted a study to determine the effects of training teachers on how to implement questioning strategies in their classroom using MRS. They found that using MRS is an effective tool to train pre-service and in service teachers.

The current study sought to examine the effectiveness of using MRSs environments to develop skills in the use of discussion between teacher and students in an elementary mathematics methods course. The intent was to use the simulation as a way to enhance their ability to elicit evidence of students' mathematical knowledge and understanding through the use of productive mathematical talk moves (Chapin, O'Connor, & Anderson, 2009). In this regard, the research questions of this study are: To what extent do pre-service teachers trained on the use of Productive Mathematical Talk moves (PMTM) through MRSs are more likely to use them to elicit their students' thinking in a clinical interview than their

counterpart not exposed to? and to what extent does the exposure to MRS help elementary pre-service teacher build their confidence and skill in the use of Productive Mathematical Talk-Moves?

Theoretical framework

Mathematics teachers make decisions regarding the best way to provide their students with opportunities to reason, and discuss with classmates, for developing conceptual understanding (Battista, 2016). Listening to students is an important skill that includes observation of students and their work in order to make the best instructional changes (Jablon, Dombro, & Dichtelmiller, 1999). Mathematical discourse is one way to improve students' understanding in which students reveal their thinking while teachers make productive talk moves (Chapin, O'Connor, & Anderson, 2009; Ginsburg, 1997; Kazemi, 1998). Productive talk moves are techniques used in the classroom for fostering understanding in a context of discourse. In this sense, Chapin et al., (2009) described productive talk moves as "instructional strategies to enhance class discussions in order have high quality discussions that engage and further students' understanding" (p. 4), with the intention of increasing the rigor in class, and to elicit the students' thinking in a way that enhances both the individual and collaborative learning environment. Discussions, not only provide windows into what students know, but also offers a look into the approaches they use, the degree to which they understand the ideas (Kersaint, 2015). In addition, Kersaint mentioned that discussion offers opportunities for students to expose their rationale and understanding.

However, teaching mathematics for understanding is a task that requires experience, technique, and practice. Eliciting student's thinking through questioning or productive talk moves entails teachers to ascertain what questions to ask, who to call on, when to intervene and when to extend their thinking (Kersaint). Experienced teachers with years of practice have developed such high leverage practices **(**Cohen, 2015). In the case of elementary mathematics teaching, it becomes necessary to train teachers in how to conduct and orchestrate mathematical classes before they have their own classrooms. They should be exposed to the process of conducting well orchestrated discussions and individual interviews to diagnosis and develop students' mathematical understandings. The type of task selected by the teacher helps to facilitate deep understandings such as those offered using Cognitively Guide Instruction (CGI), which is a student-centered approach to teaching mathematics (Carpenter, et al, 2015). These are word problems designed to allow students to use their own knowledge and understanding when solving a problem.

Teacher preparation programs provide teacher candidates (i.e., teachers about to graduate) with experiences, in safe environments, with techniques to accurately ask appropriate questions in a mathematics classroom that trigger discourse. But, pre-service teachers (i.e., teacher in their initial preparation years) have few opportunities to master how to elicit student's thinking through asking high order questions before they start their clinical teaching or service. Straub et al., (2014) defined high order questioning as "open-ended questions [starting with how, what, or why] that allow students to use past experiences, prior knowledge, and previously learned content and relate it to newly learned content in order to create a well thought-out answer" (p. 3).

To increase teaching opportunities in which elementary pre-service mathematics teachers practice asking productive questions, and eliciting students' understandings, a mixed-reality simulation (MRS) environment can be used so that pre-service teachers can practice in a nonthreatening environment— how to conduct productive talk moves. Mixed-reality has been defined as a "computer-generated display that allows participants to have a sense of being in an environment other than the one they are actually in, and to interact with that environment" (Schroeder, 2012, p. 1). Mixed-reality simulations allow pre-service teachers to interact with virtual students in which "unique learning opportunities [would emerge]…without experiencing long term consequences of their actions [and] allows them to safely practice and learn from mistakes" (Storey & Cox, 2015, p. 43). For example, according to Teaching Now (Will, 2016), teacher candidates who had the opportunity to practice in advance, using a virtual simulation program called "TeachLive," outperformed their peers that were not exposed to MRSs when evaluating student's work. This type of technology offers an alternative method to provide pre-service teachers opportunities to hone their knowledge and skills both in content and pedagogy that results in student achievement. Dieker, Straub, Hughes, Hynes, & Hardin (2014) stated that MRS "supplements real teaching but doesn't replace it, it simply enables a pre-service teacher, individually or with a coach, to work or be trained on a targeted skill in a safe environment" (p. 56). According to Dieker et al., (2014), by using mixed-reality simulations pre-service teachers can participate in structured, pre-planned rehearsals multiple times until they have acquired the desire skill, providing then the possibility of advancing their student-teacher interaction before starting their real teaching responsibilities.

Methodology

Participants

The initial stage of the current study was to introduce pre-service teachers' to productive mathematics talk moves when engaged in classroom discussion or conducting a clinical interviews. The participants were 55 teacher candidates enrolled in an elementary mathematics methods course in the spring semester of 2018. There were two sections, and both were taught by one of the researchers, who are mathematics educators. One section acted as a treatment group and was trained in the use of productive talk moves in a MRS environment, and the second section acted as a comparison group was trained in a regular classroom setting. Both sections were exposed to the same research-based readings and materials. The use of MRS to train and study pre-service teachers' use of productive mathematical talk moves is a unique strategy never used before in a Hispanic Serving Institution Educator preparation program.

One section was asked to practice their questioning and productive talks moves using a MRS software (i.e., TeachLive) that was set up with the help of the technological instructional team from the College of Education. The other section was not offered the MRS practice, instead they were trained in the classroom during the lecture sessions. Every pre-service teacher was required (as part of a course assignment) to conduct a clinical interview with an elementary student. The clinical interview was employed with the intention of showing the pre-service teachers how elementary students solve problems, how the child understands the problem, and how the child reasons when solving problems. The pre-service teachers conducted their clinical interviews with an elementary student, only after the training on how to use PMTM was finished.

Data collection and Analysis

Qualitative data were collected that included notes, audio-transcriptions, and written reflections of the clinical interview. For this paper, only interview transcriptions were analyzed. The transcriptions were coded using the categories from productive math talk moves (Chapin, O'Connor, & Anderson, 2009; Ginsburg, 1997; Moyer & Milewicz, 2002). For each course section, the frequency of category used was calculated and compared to one another. Productive math talks moves from both sections (i.e., the ones exposed and not exposed to the MRSs) were later compared.

A preliminary analysis was conducted on seven randomly selected transcriptions from each section. Table 1 presents the codes used to answer the research questions. The codes were adapted from Chapin et al., (2009); Ginsburg (1997), and Moyer & Milewicz (2002).

Code	Move Type	Characteristic
R_V	Revoicing	Paraphrasing to verify an statement
R_E	Repeating	A repetition on the original question
E	Elaborating	Request to add or elaborate a response
E_F	Elaborating-Follow-up	Following up a previous response
L	Leading	Instructing, no eliciting
W	Waiting	Allowing time in silence
N	No question	No question or move at all
LOQ	Low-order-Questions	No reasoning is encouraged, simple question.
NC	No Category	others

Table 1. Coding Scheme

Table 2 presents the coding, results of the transcriptions. The researchers obtained the frequency for each code with an initial inter-rater agreement of 82 percent that ended in 88 percent after discussing differences.

Code	Move Type	Regular instruction	TeachLive
R_V	Revoicing	2	7
R_E	Repeating	3	2

E	Elaborating	12	12
E_F	Elaborating-Follow-up	6	4
L	Leading	2	12
W	Waiting	0	2
N	No question	1	0
LOQ	Low-order-Questions	8	15
NC	No Category	1	2
	TOTAL	34	56

Table 2. Preliminary Results

Significance

When the productive mathematical moves of both the treatment and control group were analyzed, a different between these groups was evidenced. The results showed that not all the moves of the treatment group (the group exposed to the MRSs) were productive. In fact, the treatment group showed an inclination for using leading moves as opposed to the control group. Pre-service teachers exposed to the MRS were able to attain more confidence in interacting with elementary students, something that were not observed in the transcripts of the control group, but these do not represent an indication of mastering the skills of using productive mathematical talk moves to elicit the students' thoughts or assessing the student's understanding.

Although leading could be seem as positive characteristics of a high quality teacher who worries for the learning process of his or her students, in the context of assessing and eliciting, it would means that the teachers are providing the students with the answers instead of giving them time to respond. These might indicate a certain level of frustration on the teachers' regard, which is projected through the impatience process of leading. Nevertheless, the use of MRSs is to provide pre-service teachers with the experience and practice of assessing and eliciting their students' thoughts, however the number if interactions with the simulations play an important role in developing these skills.

The findings of this report are preliminary and the study is on-going. A limitation of the study was that the treatment group were only exposed to the simulation one time, and although feedback was provided in class, more time and practice would be needed in training on the use of Productive Mathematical Talk moves. As research has indicated, a participant would need to be exposed to a simulation experience in between three to five times in sessions ranging from five to ten minutes to acquire and master a skill (Dieker et al., 2014). Future research will examine outcomes of the pre-service teachers exposed to multiple training sessions and correlated with their real-life clinical experience.

References

Andreasen, J. B., & Haciomeroglu, E. S. (2009). Teacher training in virtual environments. *Paper presented at the annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, Atlanta, GA.

Battista, M. T. (2016). *Reasoning and sense making in the mathematics classroom, pre-K-grade 2*. Reston, VA: National Council of Teachers of Mathematics.

Carpenter, T. P., Carpenter, T. P., Fennema, E., Franke, M. L., Levi, L., & Empson, S. B. (2015). *Children's mathematics: Cognitively guided instruction* (2nd ed.). Portsmouth, NH: Heinemann.

Chapin, S. H., O'Connor, C., O'Connor, M. C., & Anderson, N. C. (2009). Classroom discussions: Using math talk to help students learn, Grades K-6. Sausalito, CA: Math Solutions.

Cohen, J. (2015). Challenges in identifying high-leverage practices. *Teachers College Record*, *117*(7), 1-41.

Darling-Hammond, L., Chung, R., & Frelow, F. (2002). Variation in teacher preparation: How well do different pathways prepare teachers to teach? *Journal of Teacher Education, 53*(4), 286-302.

Dieker, L. A., Straub, C. L., Hughes, C. E., Hynes, M. C., & Hardin, S. (2014). Learning from virtual students. *Educational Leadership*, *71*(8), 54-58.

Everling, K. M., Delello, J. A., Dykes, F., Neel, J. L., & Hansen, B. (2015). The impact of field experiences on pre-service teachers' decisions regarding special education certification. *Journal of Education and Human Development*, *4*(1), 65-77.

Freeman, G. G. (2010). Strategies for Successful Early Field Experiences in a Teacher Education Program. *SRATE Journal*, *19*(1), 15-21.

Ginsburg, H. (1997). *Entering the child's mind: The clinical interview in psychological research and practice*. Cambridge University Press.

Hatton, S., Birchfield, D., & Megowan-Romanowicz, M. C. (2008). Learning metaphor through mixed-reality game design and game play. *Proceedings of the 2008 ACM SIGGRAPH symposium on Video games*. 67-74. 10.1145/1401843.1401857

Hoth, J., Döhrmann, M., Busse, A., König, J., & Blömeke, S. (2016). Diagnostic competence of primary school mathematics teachers during classroom situations. *ZDM Mathematics Education, 48*, 51-53.

Hixon, E., & So, H. J. (2009). Technology's role in field experiences for pre-service teacher training. *Journal of Educational Technology & Society, 12(4),* 294-304.

Jablon, J. R., Dombro, A. L., & Dichtelmiller, M. L. (1999). *The power of observation*. Washington, DC: Teaching Strategies, Inc.

Kersaint, G. (2015). *Orchestrating mathematical discourse to enhance student lea*rning. North Billerica, MA: Curriculum Associates, LLC.

Kazemi, E. (1998). Discourse that promotes conceptual understanding. *Teaching Children Mathematics, 4*(7), 410-414.

Lindgren, R., Tscholl, M., Wang, S., & Johnson, E. (2016). Enhancing learning and engagement through embodied interaction within a mixed reality simulation. *Computers & Education, 95*, 174-187.

Moyer, P. S., & Milewicz, E. (2002). Learning to question: Categories of questioning used by preservice teachers during diagnostic mathematics interviews. *Journal of Mathematics Teacher Education, 5*(4), 293-315.

Peterson-Ahmad, M. (2018). Enhancing pre-service special educator preparation through combined use of virtual simulation and instructional coaching. *Education Sciences*, *8*(1), https://doi.org/10.3390/educsci8010010.

Schroeder, R. (Ed.) (2012). *The social life of avatars: Presence and interaction in shared virtual environments*. London: Springer-Verlag.

Straub, C., Dieker, L., Hynes, M., & Huges, C. (2014). *Using virtual rehearsal in TLE TeachLivE™ mixed reality classroom simulator to determine the effects on the performance of mathematics teachers. 2014 TeachLivE™ National Research Project: Year 1 Findings.* University of Central Florida, Orlando.

Storey, V. A., & Cox, T. D. (2015). Utilizing TeachLivE™(TLE) to build educational leadership capacity: The development and application of virtual simulations. *Journal of Education and Human Development, 4*(2), 41-49.

Will (2016). Digital classroom simulations signal new frontier in teacher training [Blog Post]. Retrieved from http://blogs.edweek.org/teachers/teaching_now/2016/04/classroom_simulations_uva.html.

Weber, S. (2017). The impact of service learning on pre-service teachers' preconceptions of urban education. *Journal of Inquiry and Action in Education*, 8(2), 21-33.