Enhancing Preservice Elementary Teachers’ Field Placements in Math and Science through Videoconferencing

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Abstract This study was designed to examine benefits and challenges of teaching through videoconferencing in the context of students’ field placement experiences, particularly as it relates to an inquiry-based approach to teaching and learning math and science. In the context of mathematics and science methods courses, preservice teachers, with the supervision of professors, field placement supervisors and cooperating teachers, taught a series of math and science lessons via video conferencing to 5th grade classes in a major urban public school. Two major results of this study indicate that: 1) teaching through videoconferencing highlights strengths and weaknesses in questioning skill techniques that are at the heart of an inquiry-based approach; 2) teaching through videoconferencing raises the intellectual challenge of teaching and allows preservice teachers to look face to face into their limited understanding of the content matter in math and science.

Introduction
The need to renovate and re-invent the teacher education program at a northeastern university led a group of professors from the department of Curriculum and Teaching to initiate a videoconferencing study with undergraduate preservice elementary teachers in mathematics and science methods courses. The purpose was to examine the benefits and challenges of videoconferencing as a lens for analyzing teaching practices.
An initial study (Joseph, Plonczak, Stemn, 2008) revealed that teaching through videoconferencing highlighted the difficulties and the importance of having good questioning skills and good knowledge of the content matter in mathematics and science, as well as the importance of receiving immediate feedback from professors and peers. Drawing from these results, in this study we focus on how videoconferencing impacts preservice teachers’ understanding and implementation of inquiry-based approaches to teaching and learning math and science.

Theoretical Framework
There has been a limited amount of research that has explored the use of videoconferencing as a tool to enhance teaching and learning in the context of teacher education (Gage, 2003; Heath & Holznagel, 2002). This may be due to the fact that many educators and researchers have reservations in the use of videoconferencing in education. They argue that VC does not provide the sense of reality that exists when a teacher and student are in the same room, and at best it is a virtual experience (Hirsh, Sellen, & Brokopp, 2005). Others argue that eye contact, a vital component of teacher-student interaction, is lost through VC (Carter, Clarke, Graham, & Pomfrett, 1995). Other challenges in using VC are that it is difficult to listen to conversations that occur during group work (Phillion, Miller, & Lehman, 2005), and lecturers must plan diligently at encouraging interactivity (Mason, 1994).
However, a study conducted by Gage (2003) found that videoconferencing has great potential for developing mathematical communication skills within the classroom. Gage explored how teachers and students in two schools on the south coast of England viewed videoconferencing, and whether videoconferencing a math lesson would help students develop their mathematical communication skills. Findings show that students were motivated and eager to interact with students in the other school, but the act of communicating proved to be more difficult than they had anticipated. Some of the students felt shy and uncomfortable talking about math during the videoconference, and they found it hard to judge whether other students had understood what they said. Also, they felt that having to speak in front of a camera placed a lot of pressure on them to communicate their mathematical ideas clearly, efficiently and effectively. However, from a cognitive perspective, the teachers who participated in the study felt that videoconferencing forced students to think about how they were going to communicate mathematically.

Another study conducted by the Alberta Ministry of Education reported successful outcomes while using an inquiry based approach through videoconferencing. Video-conferencing technology was observed to enhance regular classroom delivery by allowing students to engage in learning activities with peers, experts, and other educational resources outside of their traditional classroom. Students generally enjoyed these enrichment activities and seemed eager to expand their learning opportunities using the technology. The technology also fit with some inquiry-based learning designs and allowed students to interact first hand with experts and remote students with particular skills and interests. The study reports that students were more engaged when an inquiry-based approach was employed.

Understanding what we mean by an inquiry-based approach is fundamental at this point, because, as Minstrell and van Zee (2000) report, many teachers understand inquiry simply as a teaching strategy based on hands-on activities. But this is not enough. As stated in the National Science Education Standards, students need opportunities to ask questions and establish a dialogue that will allow them to construct their own explanations of the challenges or situations presented to them, to consider the evidence that confirms or disconfirms these explanations, and to articulate the arguments that support these explanations. Therefore, as Lehrer, Carpenter, Schauble, and Putz (2000) point out, effective science teachers consider a three step process that starts by asking challenging questions (questioning), encouraging the students to come up with ways of collecting evidence that will test their assumptions (experimentation), and assisting and guiding students as they construct convincing and viable argument that will support their explanations (argumentation). Hands-on activities can definitively be constant throughout this process, but each one of the steps is fundamental in terms of engaging in a meaningful experience of construction of scientific knowledge.

Even though an inquiry-based approach should be central to the methods courses and teaching practices – as mandated by the National Research Council (2000) – scientific inquiry is not necessarily what is observed when elementary preservice or beginning teachers engage in teaching practices. Research suggests that this is in part due to their lack of knowledge of the content (Ma, 1999; McDiarmid, 1990; Bransford, Brown and Cocking, 2002; Appleton, 2003, 2005).

One of the main difficulties elementary preservice and beginning teachers encounter when teaching math or science is dealing with unforeseen questions and events (Nilsson, 2008). Even though the preservice teachers realize they have difficulties dealing with unexpected questions, they do not perceive posing questions as a concern or difficulty unless they are explicitly
exposed to their lack of skill to pose the kind of questions that lead to understanding. According to Nilsson, preservice teachers expect their students to ask them questions, not the other way round. They don’t realize that the students are not asking interesting questions because the teacher is not doing it either, mainly because of the teacher’s limited understanding of the content knowledge.

In this study we analyze the potential of videoconferencing for teacher education. We are interested in examining the benefits and challenges of teaching through videoconferencing particularly as it relates to an inquiry-based approach to teaching and learning math and science. We examine how teaching through videoconferencing makes preservice teachers reflect on their own lack of content knowledge and how their lack of understanding limits their possibilities to ask questions conducive to learning.

The questions that guided our research were the following:
1. How does videoconferencing impact preservice teachers’ perception of the importance of having good questioning skills?
2. How does videoconferencing impact preservice teachers’ perception of the necessity of having good knowledge of the content matter in science?

The Study
This study was conducted in the context of the elementary math and science methods courses of a northeastern university’s teacher education undergraduate program. Each of the methods courses meets twice a week for an hour twenty-five minutes for 12 to 3 weeks. The courses have a 45 hour field experience requirement in math and another 45 hour field experience requirement in science. Pre-service teachers were supervised by a field placement supervisor, by a cooperating teacher, and by their course professor, and during four sessions, they were observed by their supervisor as they taught a twenty minute lesson to a small group of students. For this study, one of the four supervised sessions was replaced by the videoconferencing experience. Fifteen preservice teachers were placed in six groups of two or three. Three groups prepared a mathematics lesson and the other three a science one. The three mathematics lessons focused on algebraic thinking while the science lessons centered on greenhouse effect and global warming. Each group planned the lessons, communicated with the classroom teachers about the resources and materials needed for the children. Each of the lessons lasted approximately 30 to 45 minutes, and was followed by a collective discussion and reflection.

Data were collected in the form of group discussion and reflection of teaching episodes, observations, individual written reflections, group discussion on blackboard, informal interviews, recording of videoconference sessions, and lesson plans. The group discussions took place immediately after each lesson was taught focusing on the strengths of the lesson and what was identified as problematic.

Results and Discussion
A variety of themes emerged from the analysis of the data. We have grouped them in terms of the strengths of videoconferencing to encourage an inquiry-based approach to teaching and learning math and science, and to its challenges. As for the strengths, the first theme that emerged was related to the questioning skills needed to teach science through videoconferencing. The second one related to the focus on the academic component of the lesson and the importance of the knowledge of the content matter, and the third related to planning. The main challenge refers to the difficulty of teaching in an environment where there is no direct face-to-face
interaction with the learners, and where interaction is based on the intellectual dialogue generated by the questions and answers between the preservice teachers and the learners.

**Strengths of videoconferencing in the context of teacher education**

1) **Good questioning skills are required to teach science through videoconferencing**

As preservice teachers experienced teaching and learning through videoconferencing they realized that their only way of communicating with the children was through the questions and challenges they posed, and these had to be perfectly well articulated and formulated:

I think videoconferencing has been beneficial for me as a developing teacher because when executing a lesson over videoconferencing you need to make sure you can probe your students with questions and since videoconferencing I have become a much better questioner.

When preparing to VC, I found it best to establish a list of questions to ask the kids because conversation is what the VC relies so heavily on. Also, conversation is how we gather information on what the students are learning when doing videoconferencing.

[Videoconferencing] helped to focus on the academic part of teaching. The questioning technique was crucial, and I had to make sure I was always clear and precise in my explanations and instructions.

[When teaching through videoconferencing] the questioning technique can make or break a lesson.

Some of the preservice teachers were concerned about the fact that they felt unprepared to ask appropriate questions, and teaching through videoconferencing highlighted this weakness:

Videoconferencing showed me that I need to work on my questioning technique.

Personally, my main concerns were my questioning skills. I know that I tend to ask a question, accept an answer, and then move on when I should really be asking more probing questions.

One of the aspects that emerged in this study is that teaching through videoconferencing made the preservice teachers realize that they need to have excellent questioning skills to teach math and science in a way that goes beyond rote learning and that emphasizes an inquiry-based approach.
2) Videoconferencing focuses on the academic component of the lesson and requires excellent understanding of the content matter

Preservice teachers realized that videoconferencing raised the intellectual requirements for teaching and that they had to be better prepared in terms of their knowledge of the subject content matter:

You definitely need a better understanding of the subject matter when you are teaching through videoconferencing.

It is important to believe and know what you are teaching so that you are ready for questions and you are conveying the correct message and information.

I think you need to pay attention more to what you are teaching because the explanations are so important.

It is important to have a wide knowledge base so you can adapt to the important ideas and questions that may arise throughout the course of the lesson.

Preservice teachers also perceived that videoconferencing focused on the content matter and not on building relationships with the students:

Teaching through videoconferencing, again forces the teacher to focus on the academic component of the lesson rather than getting to know the individual students. It also forces the teacher to prepare better for the lesson.

I feel that preparing and delivering a lesson via videoconferencing has helped me develop as a teacher. As I mentioned in class and in other reflection on videoconferencing, I have learned that there is so much more than being a “nurturing” teacher. Teaching students that I have never met before has definitively made me realize how important the intellectual aspect of delivering a lesson is.

Videoconferencing forces you to really rely on your questioning skills and content knowledge. Since you do not have your personal relationships to engage the students, you really need to be doing something exciting and interactive for the students to be motivated for a stranger.

A supervisor made a statement during one of the first videoconferences that I completely agree with: Teaching via videoconferencing cannot be compared to teaching face-to-face. Teaching face-to-face allows for a building relationship with your students. Videoconferencing relies solely on teaching academia.

Preservice teachers could not recur to the social and emotional connections that occur in face-to-face classrooms, and could rely only on their knowledge of the content matter to ask the appropriate questions that would pursue the dialogue and interaction. This is important in the
context of elementary teacher education, because preservice teachers often hold the false assumption that it is enough for an elementary teacher to be caring and nurturing, and they are dismissive of the importance of having good knowledge of the content matter in order to create an environment conducive to meaningful learning.

3) **Videoconferencing forces you to plan rigorously and prepares you to deal with the unexpected**

The preservice teachers also mentioned that it was more difficult for them to deal with the unexpected in the context of videoconferencing than it would be in an on-site classroom, and that as a consequence, they did not know what to do with children’s responses that were contrary to their thinking:

I know that if I were in a classroom, it would have been easier to adjust the lesson while going through it. Preparation and being organized allows for a well-conducted lesson. I learned that even though you might have a lesson all planned out, and a tentative set plan, the students will bring you places you never expected to go, and are not prepared for. But as a teacher you need to know how to deal with that, and re-shape your lesson to go along with the students’ ideas.

The preservice teachers didn’t know the content well enough to ask questions that would allow the learners to construct their own understanding. As a consequence, they did not know what to do with children’s responses that were contrary to their thinking. The videoconferencing context helped students realize the importance of being prepared and being able to anticipate the often unexpected student responses and questions:

The most important thing I learned is to be prepared for anything. Students can say the most random things and you have to know how to deal with it on the spot. Unexpected occurrences and learning to be flexible is a positive because you don’t know the students or what they are capable of, you have to quickly adapt to what they do or don’t know. That is excellent practice of our prep for our future teaching positions.

With respect to the above quote, many of preservice teachers interpreted the elementary students’ questions as random because they did not anticipate the student’s level of understanding of the content material. In our peer debriefing sessions, the pre-service students noted that elementary students had a deeper understanding of the subject area than they thought they would. Preservice teachers also found it difficult to ask the appropriate questions to further the elementary student’s understanding that would engage students in meaningful dialogue. The preservice teachers, for lack of knowledge, didn’t ask good questions, and even if they received good answers from the students, they didn’t know how to respond to them. They responded with the typical “very good” to all answers. Being unable to deal with the unexpected appears to be a consequence of preservice teachers’ limitations in the knowledge of the content matter, and not of the videoconferencing setting.
Challenges of videoconferencing in the context of teacher education:

An example of the difficulty to make the shift from a learning environment based almost exclusively on nurturing and caring to a more academic one is expressed by the following preservice teacher: This preservice teacher found that teaching through videoconferencing made it difficult to move away from a lecturing style to a student centered one:

I felt my style of teaching unconsciously changed to reflect that. It did not feel like I was in a classroom teaching students anymore. I felt as if I was putting on a show. As such, I began to lecture more than I normally would.

Preservice teachers are exposed to different strategies for designing and teaching student centered lessons throughout their methods classes, and they understand and believe in the benefits of student centered classrooms. However, in the context of videoconferencing they found it difficult to implement a student centered approach and instead resorted to a lecture style and teacher center approach.

Conclusion

In this study we were interested in exploring the potential benefits and challenges of videoconferencing as a lens by which to analyze elementary preservice teachers’ instructional practices. We were particularly interested in studying how videoconferencing impacts preservice teachers’ understanding and implementation of inquiry-based approaches to teaching and learning math and science.

Using videoconferencing the way we’ve described in this article gives us a new window into the problems and difficulties preservice teachers have as they struggle to construct an understanding about what it means to teach math and science. Our analysis of the data suggests that because the preservice students don’t know the subject matter, they don’t know what questions to ask, and if they don’t know what questions to ask, they can’t have a student centered classroom. By not having a good grasp of the subject matter our preservice teachers resorted to using teacher-centered instructional strategies. The issue at stake is not the nature of videoconferencing but the lack of understanding of the content matter, and what is important in the context of videoconferencing, is that it allows preservice teachers to look face to face into these limitations.

The main implications of this study for teacher education programs are:
1. Videoconferencing highlights strengths and weaknesses in questioning skill techniques that are at the heart of an inquiry-based approach to teaching and learning science.
2. Videoconferencing raises the intellectual challenge of teaching and allows preservice teachers to look face to face into their limited understanding of the content matter in science. In the field of elementary education many preservice teachers assume that they may not need in depth knowledge of their content, these students saw that they had to know their content well and anticipate where students may have gaps in their understanding.

This study shows that videoconferencing highlights the importance of having solid subject matter knowledge and a repertoire of questioning skills that will allow preservice elementary teachers to
engage in an inquiry-based approach necessary to enhance the teaching and learning process in mathematics and science classes.

References


