The Impact of Technology on a Graduate Mathematics Education Course

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Given the rise in distance delivered graduate programs, educators continue to seek ways to improve teaching and learning in an online environment. In particular, the need for high quality K-12 teachers requires superior teacher-education programs that model good instructional practice, especially in mathematics. In this article, the instructor of a mathematics education course describes the opportunities and difficulties he encountered in designing and implementing an online course for inservice mathematics teachers. In addition to anecdotal evidence from class observations, researchers collected survey data from participants. Results of these data are presented and used with the instructor's reflections to make specific recommendations for improving the course and to offer insight to others using distance-learning technology to teach graduate mathematics education courses.

Key Words: online professional development, mathematics teacher education, teaching geometry

The advances in online technology continue to transform how university faculty can provide teacher professional development (Hramiak, 2010). Advocates of online teacher education maintain that it "holds the possibility of developing not only vibrant explorations of knowledge and practice in the content area, but also communities of learners and practice, and lifelong learning perspectives and skills" (King, 2002, p. 224). Concurrently, problems in the design and implementation of online courses may hinder learners in these environments. Given the demand for high-quality teachers, online courses appear to be an increasingly popular way to provide teacher professional development (Signer, 2008). However, there is a clear need for continuing research in online teacher professional development to ensure that it is meeting the professional needs of teachers (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009).

The purpose of this paper is to present results of an investigation into the design and implementation of an online mathematics teacher education course for secondary inservice teachers as part of the Mathematics Teacher Leadership Center (Math TLC). The Math TLC is a collaboration among the University of Northern Colorado, the University of Wyoming, and partner school districts in Colorado and Wyoming in the United States and is funded by a National Science Foundation[1] Mathematics and Science Partnership. One goal is to help develop culturally competent master teachers to work locally, regionally, and nationally to improve teacher practice and student achievement. Designers of the course relied on recommendations from the literature including purposeful attention to instructor roles and community. Researchers administered a survey to course participants to obtain feedback from teacher-participants about their attitudes about the impact of technology on their learning. With these empirical results as well as observations and notes taken during the semester the instructor offers recommendations to improve the mathematics education course he taught.

Literature

In examining the available literature concerning online teacher education programs, two emerging themes are particularly helpful to frame the design of the teaching geometry course: instructor roles and community. The roles of distance education instructors, while similar to face-to-face instructor roles, have the added dimension of the necessary use of technology. Maor (2003) and Johnson and Green (2007) categorized the roles of distance education instructors as pedagogical, managerial, social, and technical. The *pedagogical role* entails all of the abilities involved in delivery of content, included the ability to make instructional decisions, develop appropriate learning tasks, facilitate learning, and assess for understanding. The *managerial role* comprises the abilities to administer the course, including the skills plan the scope and sequence of the online course, monitor the teaching and learning processes, and manage the constraints of the course, including the timeline. The *social role* includes the ability to provide one-on-one, emotional support and advising to participants. The *technical role* includes the proficiencies involved in the decision-making process of selecting technology, the aptitude to use technology, and the ability to trouble-shoot problems with the technology quickly so that participants may remain focused on learning the material. Each of these roles – pedagogical, managerial, social, and technical – is thought to encompass the duties and tasks of the instructor and, when performed professionally and proficiently, is assumed to ensure a positive learning environment.

Equally important to the success of online courses is the presence of learners' sense of community, which is typically defined as feelings of trust, belonging, commitment, and shared

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goals among online learners (Shea, Li, Swan, & Pickett, 2002). Rovai (2002b) claims the sense of connection among learners helps overcome feelings of isolation caused by physical distance. Other researchers find that graduate students in online programs that have a higher sense of community also have lower attrition rates, increased student learning outcomes, and higher levels of satisfaction and engagement (Lui, Magjuka, Bonk, & Seung-hee, 2007; Shea et al., 2006).

Research Methods

There were 22 participants in the course consisting of inservice secondary (grades 7-12) mathematics teachers working towards a master's degree of the Math TLC. Because of the relatively sparsely populated nature of northern Colorado and Wyoming, the participants were spread out geographically over the two states, though all learners were within 250 miles of one other. The participants had met in person during a six-week session the previous summer, about seven months prior to the start of the course.

The teaching geometry course took place during a 15-week semester in the spring of 2010 and focused on current research and practices of teaching, learning, and assessing geometry in secondary schools. The course was conducted completely online with both asynchronous and synchronous components. Participants used the course management system Blackboard to access course materials and submit assignments as well as to post occasionally on assigned discussion board topics. The participants of the course used the online collaboration software Elluminate to meet virtually every Monday night in a webinar, where live audio and video conferencing was used to facilitate real-time class discussions, small group work, and lecture. The instructor frequently used Elluminate to poll participants for informal feedback as well as put participants into small groups for discussion, followed by whole-group discussion paired with the lesson's PowerPoint slides visible to everyone. Participants received the PowerPoint slides and other required readings electronically, prior to the start of the webinar as recommended by Hofmann (2004). Virtual office hours were held on Elluminate and email was used regularly for the instructor and participants to communicate.

Survey data were collected at the end of the semester through an electronic survey with quantitative questions. Thirteen of the 22 participants completed the survey, with questions focusing on the implemented technology of the course. The instructor and graduate assistant of the course took notes during the semester about the structure and effectiveness of the course webinars and recorded the webinars for later viewing. Both qualitative and quantitative data were used in the investigation.

Results

Overall findings from the survey and observational data indicated participants had successful learning experiences with the class. Most participants indicated they were satisfied with all four roles of the instructor; specifically participants rated technological and pedagogical roles highest, with social and managerial roles receiving positive but more widely distributed responses. Positive feelings of community were indicated by most participants, though one individual reported feelings of isolation from the rest of the class. In addition to the survey results from the participants, the instructor provided reflective comments on the four roles based on the survey results.

With respect to the pedagogical role, course participants generally held favorable views of the course design, including learning tasks and weekly webinar interactions. The instructor was a veteran instructor of the teaching geometry course. However, the instructor felt this role was time consuming mainly because the course expectations were set too high. The time commitment involved for the instructor, as well as the participants, exceeded that of a two-credit

master's-level course, including the design of the weekly tasks and the assessment of participants' work. Additionally, a few participants indicated they were only sometimes satisfied with the amount of contact they had with the instructor. On reflection, the instructor indicated this is an aspect that needs improvement, as research indicates online instructors must work harder than face-to-face instructors to establish rapport and open lines of communication with learners (Rovai 2001, 2002a, 2002b; Shea et al., 2006).

The technical role was also a significant aspect of the duties of the instructor. Course participants generally thought that technology was used to promote learning. Although the instructor was a novice user of Elluminate, the instructor felt that decisions involving the use of polling as a formative assessment, the use of breakout rooms for small-group discussion, and the capability of multiple video and audio interactions contributed to these positive learning experiences. Additionally, a majority of participants indicated that technology concerns sometimes interfered with their understanding. The instructor felt that more experience with the technology may increase his ability to act as technical advisor and be a better initial source for solving technical problems.

The managerial and social roles had the added restriction of the separation between the instructor and the participants compared to face-to-face instruction. For example, managing the weekly webinars required explicit attention to environmental norms, such as the use of the chat box and the use of video for course discussion; whereas in face-to-face instruction most classroom norms in college classrooms are implicit based on common educational experiences. The newness of these experiences may have contributed to participants' varied views on interactions during the webinars. Participants, however, generally viewed the social role of the instructor as favorable.

Implications and Future Research

From the data gathered over the duration of the semester, the instructor compiled recommendations for future instructors of online mathematics education courses in this program. The use of break-out sessions and polling in the course was deemed important by both instructor and participants not only as tools for learning but also for community building. Teacher-participants considered a sense of community an important factor in their learning, a finding supported by literature (Rovai 2001, 2002a). The results indicated most learners were satisfied with the amount of community they felt, though a few were only slightly satisfied. Now aware of both the importance and the challenge of building community in online courses, the instructor suggests that this aspect of the course be a focus in the future.

Overall, the instructor and the participants thought that the course was educationally successful. In the future, the instructor plans to continue incorporating technology that fosters knowledge and community building. Evaluating his own teaching using the four instructor roles was helpful in identifying strengths and areas for improvement in the online course, and he recommends this approach for other educators.

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