Using an Online Community of Practice to Foster Inquiry as Pedagogy amongst Student Teachers

Oliver Dreon Jr., Scott P. McDonald, 146 Chambers Building, Pennsylvania State University,
University Park, PA 16802
Tel: 814.865.2190 Fax: 814.863.7602
Email: ozd102@psu.edu, smcdonald@psu.edu

Abstract: Research has shown how individual components of an online environment such as blogging or discussion boards can be effective tools with learners and preservice teachers. This study examines how an integrated, comprehensive online environment can be used as a component of a community of practice to develop student teachers' conceptions of inquiry as science pedagogy. The community of practice studied was unique being comprised of highly-experienced teachers that are all engaged in doctoral level science education research. The online environment was used by entire community to reflect and communicate about the theory and practice of inquiry science pedagogy. Student teachers' conceptions of inquiry science pedagogy were studied via data collected through the online environment (student teachers' online journals, posts to threaded discussions, and usage patterns).

Introduction

The context of this research study is a geographically distributed professional development school for secondary science teachers, the Invisible College for Inquiry Science Study (ICISS). The focus of ICISS is integrating educational research with science pedagogy to understand and enact inquiry science. The group was assembled by a Penn State faculty member in Science Education. The founding members of the group consisted of four practicing secondary science teachers of various disciplines (Earth and Space Science, Chemistry, and Physics). Each founding member had more than five years of teaching experience and shared an interest and common respect for the role of educational research in informing their practice. Additionally, each of the members utilized inquiry lessons in their classrooms and expressed interest in studying inquiry pedagogy for personal growth and research. After several initial meetings, ICISS added a small cohort of student teachers with founding members acting as mentor teachers. Currently, all participants are engaged in educational research as undergraduate, masters, or doctoral students.

Although Penn State acts as the central virtual hub of ICISS, members of the group are geographically distributed across Pennsylvania. An online environment was created to support the group's practice, communication and reflection. The space allowed the student teachers and practicing teachers to collaborate on projects, reflect on their teaching and develop better science pedagogy. Besides communicating with each other in the online environment, the ICISS community assembled regularly to discuss on-going projects and communicate student teachers' progress. While the student teachers were supported locally by their mentor teachers, other ICISS members visited schools to make observations and collect data in the form of lesson videtapes. These face-to-face meetings helped to support the function and development of the ICISS group as well as support the student teachers in their development.

By studying the data available in the online environment and interviewing the student teachers, we wanted to learn: How can a community of practice consisting of expert science teachers and university faculty, collaborating in an online environment foster student teachers' understanding of the integration of theory and practice in inquiry science pedagogy?

Communities of Practice

Communities of practice have been used in various contexts to enculturate people into new professions and train individuals for new fields of work (Lave & Wenger, 1991). In a community of practice, a novice develops the skills and understandings of a trade by interacting and working with more experienced individuals in the field. Learning in a community of practice occurs through social participation in the community and through the apprentice building an identity with respect to the community (Wenger, 1998).

In education, communities of practice have been used as contexts for professional development among teachers (Grossman, Wineburg, & Woolworth, 2001; Moore & Barab, 2002; Palincsar et al, 1998) and for the education of preservice teachers (Eick & Dias, 2004). The ICISS community of practice attempts to combine these functions by having student teachers participate a community of practice of expert teachers who are engaged in developing and studying their own inquiry science pedagogy.

Online Environments

The internet provides unique opportunities for learning and communicating. Besides interactive websites that can be used for commercial and educational purposes, the internet also provides a setting where individuals can present their ideas, opinions, and feelings for others to read and respond. The ICISS online environment incorporates several features that foster communication, education and reflection. Table 1 below shows each of the features of the ICISS online environment and their functions.

Table 1: Features of the ICISS online environment

Threaded Discussion Board	Spports communication amongst group members about research and pedagogy
Online Journal Space	Allows each member to post personal reflections on their classroom experiences
Digital Library	Repository of research articles related to goals of ICISS
Chat	Promotes real-time communication amongst group members

Research shows that online features can be powerful tools in teacher development and preparation. Xie and Sharma (2005) report that online journals can be "helpful for learning, reflecting and building a sense of community" amongst doctoral students in a graduate course. Poling (2005) reports that online journals can be effective with professional development amongst practicing teachers. Online portfolios have been shown to aid prospective teachers' development of reflective practice and instructional philosophy (Zembal-Saul & Avraamidou, 2002). Martindale (2005) outlines various asynchronous (e-mail, discussion boards, and online journals) and synchronous (chat, instant messaging, and audio and video Web-based conferencing) tools and their individual benefits to distance learning among adult students. Eick and Dias (2004) studied how student teachers' online biographies can be used in conjunction with coteaching strategies to develop concepts of inquiry. When designing the online environment for ICISS, we chose to incorporate features that would facilitate student teacher interaction with the community of practice.

In the last several years, many online environments have appeared to serve educational communities. Tappedin.org is an online learning environment designed to provide professional development resources for educators.(Schlager & Schank, 1997) Curriculum Access System for Elementary Science (CASES) is an online environment that helps promote inquiry-oriented science by providing educative curriculum materials for new elementary science teachers (Davis, Smithey, & Petish, 2005). The Elementary and Secondary Teacher Education Project (eSTEP) supplies video cases of classroom practice and provides tools to promote collaboration and reflection among science teachers in a problem-based learning environment (Hmelo-Silver et al, 2005). The Knowledge Network on the Web (KNOW) supports teachers as they implement inquiry-oriented curricula. (Fishman, 2000) Although drawing on some of the same features as these prior projects, ICISS uses its online environment to support a community of practice of research-oriented expert teachers collaborating for the purpose of developing inquiry science pedagogy both for themselves and their student teachers.

Inquiry Science Pedagogy

The term "inquiry" has become ubiquitous in the educational community, especially in the field of science education. The National Research Council's (NRC) National Science Education Standards (National Research Council, 1998) and the American Association for the Advancement of Science's Benchmarks for Science Literacy (American Association for the Advancement of Science, 1993) have both focused on the importance of using inquiry as an instructional model to teach science. The NRC views classroom inquiry as engaging students in scientifically based questions and having students use evidence to formulate and communicate explanations (National Research Council, 2000). While this view provides a concrete basis of the goals of inquiry, how these goals translate into practice is still not clearly articulated. Research has found that teachers confuse inquiry with other experimentally-driven methods such as hands-on instruction or discovery learning (Abd-El-Khalick et al, 2004). While these instructional methods may involve students doing some of the physical processes or activities of science, the goals of inquiry are much different. It seems that the overuse and misuse of the term "inquiry" by science educators has created confusion regarding what the term means and how it can be applied in practice.

It is unlikely that the "inquiry" confusion will be eased through discussion amongst scientists and researchers alone. Richardson suggests that what is needed in teacher education is a theory of education that is grounded in the act of teaching (2000). Based on this framework, the goal of ICISS was the development of a theory of inquiry science pedagogy grounded in descriptions of practice. Members videotaped inquiry lessons in their classrooms. By analyzing these lessons, we hoped to describe essential "elements of inquiry instruction" and chart the development of these elements over the course of a lesson, a unit, or an entire course. The online environment studied here supported this goal by housing these videotaped lessons and providing a location for the discussion and analysis of the lessons. The collaborative workspace allows the group to develop of a common vocabulary and common analysis tools for use with analysis of videotaped lessons.

This study focused on the student teachers' involvement in the community and how they are changed via their social participation with the group. As the group collaborates in the online environment, how does the community of practice foster student teachers' understanding of the integration of theory and practice in inquiry science pedagogy?

Participants

The participants in this study were two female student teachers, Amy and Jennifer (not their real names). At the time of the study, Amy was a graduate student working on a master's degree in education after completing an undergraduate degree in chemistry. Jennifer was an undergraduate student who majored in secondary education with a chemistry option. Both individuals completed their student teaching experience during the 2005-2006 school year with the same member of the ICISS group at a rural school 150 miles from Penn State's campus.

Data Collection

During their student teaching experience, each participant was required to post a weekly reflection in an online journal. The student teachers were originally given a general topic as a prompt on which they were to reflect. The prompt asked student teachers to describe an inquiry event they had experienced during the week and explain what about the event made it inquiry-related. Student teachers were also asked, but not required, to participate in the other features of the online environment (read and respond to posts on the discussion boards and to read journal articles that were posted in the online library, etc). Over the course of their fifteen week student teaching experience, each participant posted over twenty-five journal reflections and posts to other discussion boards. These journals became the primary source of data for this study.

Another source of data came from user logs that were generated by the online environment. These user logs tracked the features participants viewed inside the online environment and gave a comprehensive outline of their activity during their student teaching experience.

Analysis

The data from the interviews and online journals were coded following the guidelines outlined by Miles and Huberman (1984). A set of initial codes were generated and audio files of the interviews were transcribed. The

transcripts and the journal posts were coded and conjectures concerning student teachers' views of inquiry were developed. As analysis continued, the coding matrix was modified following emergent patterns. The developed conjectures were tested against the corpus of data and general themes were created. These themes were revised and clarified with input from ICISS participants and other researchers. Although data collection and analysis are on going, more than thirty journal entries have been coded for this study. From the data, several themes have developed.

Preliminary Results

Benefits of Inquiry

As the participants progressed through their student teaching experience, each began to identify educational benefits that teaching with inquiry presented. The participants outlined the critical thinking skills that inquiry pedagogy helped to develop with their students and the reliance on evidence-based claims that teaching with inquiry instills. For example, Amy writes:

> The reason we even care about this is because students need to be able to participate in a society that is increasingly scientific and technologically based. The only way students will be able to do this is to develop an understanding of how knowledge claims in science come to be developed. (Amy)

Jennifer stresses similar sentiments when she reflects on a parent's question about her instructional methods.

> "My response was that our purpose in the class is to not teach the students how to take notes, or how to form good study habits. Our mission is to get them to learn how to think on their own and take responsibility for their own actions…. Teaching him to think critically will be much more beneficial to him in college than any amount of homework will be." (Jennifer)

Personal History with Inquiry Pedagogy

During the beginning of their student teaching placement, it was apparent in their journals that both participants were grappling with the benefits of inquiry. This initial struggle may have been due to their experiences with inquiry instruction in their own education. In their journals, each participant details personal histories relating to inquiry pedagogy. Both participants highlight frustrations they had with their own educational experience and how teaching with inquiry has caused them to re-evaluate how they were taught. These reflections helped the participants put inquiry pedagogy in context with their prior experiences. For example, Amy writes:

> "If it were left up to my high school and undergraduate education, I would still believe that science is a very sterile activity that is completely devoid of any subjectivity and consists mainly of facts and formulas about how the world works. I can't believe how my mindset has changed." (Amy)

It was apparent that the student teachers were frustrated that they had no model of inquiry instruction in their own educational experiences. Without the community supporting their development, the participants may have taught as they had been taught. In the journals, the student teachers share this possibility:

> "I could just give the students a handout and have them fill in the information, but then where does the inquiry fit in?" (Jennifer)

> "I reached the conclusion that while I was comfortable with the style of lecture-based learning I had experienced all through high school and college (it being really all I have ever known), the bottom line is that it doesn't work, and I am living proof of that. I got my way through my chemistry education by memorizing lecture notes and not learning a whole heck of a lot. I concluded at that point that I minimally owed it to myself (and to the kids) to try something else." (Amy)

Student Reactions to Inquiry

The student teachers' frustrations with their own educational experiences with inquiry appeared to help them be more aware of their students' reactions to learning in a different manner. When they placed students in learning environments where they were required to think and work differently, the student teachers found that some of the students reacted negatively. In response to a journal post later in the semester, Jennifer was asked why she thought students had reacted badly to a lesson she had taught.

> "I think that students feel very frustrated with inquiry because it is 'out of the box' that we as a society have created in our schools. Students are so accustomed to being spoon fed step-by-step instructions in school, that when they are asked to think critically on their own, they are clueless." (Jennifer)

Possibly, the student teachers' own educational backgrounds helped them be more aware of the prior experiences of their students. This awareness, however, did not appear to cause the student teachers to give up on inquiry as an instructional tool in their classroom. Near the end of her student teaching experience, Jennifer reflected:

> "I really do feel that this type of teaching is far more beneficial to the students than the traditional method and I really am looking forward to using it in my own classroom." (Jennifer)

Definition of Inquiry

Despite their own educational experiences and the reactions of their students, the participants appeared to develop a sense of the benefits of inquiry instruction. It was apparent, however, that the student teachers still struggled with how to define inquiry pedagogy.

> "I, as a pre-service teacher, have always been slightly confused as to what constitutes teaching using inquiry." (Jennifer)

The online environment has supported the entire ICISS group as we develop a theory of inquiry pedagogy grounded in practice. Although our work is on-going, the group's online discussions appear to have affected the student teachers' views of what inquiry pedagogy is.

> "So I guess I view the task of ICISS as one of contextualizing what 'questioning and seeking answers' looks like in the science classroom." (Amy)

Throughout their online posts, the student teachers never explicitly defined inquiry pedagogy, reflecting the lack of clarity that exists amongst the science education community at large. The online discussions, however, may have helped student teachers understand the goals of the ICISS group and how that translates into practice.

Inquiry Enacted in Practice

Although student teachers never clearly defined inquiry in their journals, they appeared able to identify examples of inquiry in practice. For example, when reflecting on a lesson she taught, Jennifer writes:

> "(The students) dipped a toothpick that had dawn detergent on the tip into the petri dish and observed what happened. Immediately, it was obvious that the students were quite perplexed as to why the reaction happened the way it did. From there, it was up to the students to come up with a reasonable hypothesis, develop an experiment, and make a knowledge claim that could be supported by evidence from their experiment." (Jennifer)

> "The components of this activity which struck me initially as being "inquiry" were that students were charged with a goal (an experimental objective), given enough background information to get them started, and then asked to go about finding a solution to a problem which could have several novel solutions. I think these are key elements of framing an inquiry-type activity in the classroom." (Amy)

Through their journal posts, the student teachers appear to have developed an understanding of the importance of experimentation, hypothesis, and evidence-based claims on inquiry instruction and how they can be enacted in practice.

Value of the Online Environment

The online environment was created to foster reflection, communication and education among group members. After reading their journals, it appears that the student teachers' viewed the online environment as supportive to their development as teachers and helpful in building their understanding of inquiry pedagogy. Throughout their student teaching experience, the group supported Jennifer and Amy by responding to questions they had posed in their journals and providing advice or encouragement when warranted. This communication appeared to aid the participants' development as teachers and with their understanding of inquiry.

> "Hearing many different and intriguing thoughts from teachers with years of experience has greatly helped me to think and consider my own ideas and opinions of how science should be taught. I look forward to talking and learning more about the positive effects of inquiry in the classroom and how I can incorporate this into my own teaching." (Jennifer)

> "Thanks to all for the really thoughtful and really helpful responses to my last entry. I have printed them out and have been continuing to read over them through the week. Its really nice to know that there is such a tremendous support group out there." (Amy)

Use of Space

Analysis of user logs shows that participants used the features of the online environment primarily as resources during their student teaching experience. From the data, student teachers did not actively post in the discussion boards. Only three posts were found amongst all of their activity. The student teachers did, however, frequent the discussion boards and read the posts made by the rest of the group. The user logs also show that student teachers viewed the files in the video library and the journal articles in the digital library. It appears that the student teachers viewed the online environment as a resource that complemented their student teaching experience and helped them enact theory with their practice.

> "[The mentor teacher] and I have many conversations during the school day that are helping me to think about and develop my own ideas more and more as I go along. I don't have my own full set of beliefs yet, so at this point it is much more beneficial for me to hear the various opinions of other people and then to start thinking about my own teaching." (Jennifer)

Conclusions

This study analyzed the journal reflections, posts to threaded discussions, and user logs of student teachers working within a community of expert teachers with strong educational research backgrounds and interests. The multi-featured online environment used by the community was a useful resource for the student teachers. The social collaboration amongst the community helped to develop student teachers' understanding of the integration of theory and practice of inquiry pedagogy. By working within a community of practice, student teachers developed concepts of student benefits from inquiry pedagogy. Participants were able to contrast inquiry instruction with their own educational backgrounds and detail how students react to teaching science with inquiry. Although the participants did not finish their student teaching experience with a single, clear definition of inquiry pedagogy, they were beginning to identify examples enacted in practice..

References

Abd-El-Khalick, F., Bourjaoude, S., Duschl, R., Lederman, N. G., & et al. (2004). Inquiry in Science Education: An International Perspective. *Science Education, 88*(3), 397-419.

American Association for the Advancement of Science. (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press.

Davis, E. A., Smithey, J., & Petish, D. (2005). *Designing an Online Learning Environment for New Elementary Science Teachers: Supports for Learning to Teach*.Unpublished manuscript.

Eick, C., & Dias, M. (2004). Building the Authority of Experience in Communities of Practice: The Development of Preservice Teachers' Practical Knowledge Through Coteaching in Inquiry Classrooms. *Science Teacher Education*, 471-491.

Fishman, B. J., Best, S., Foster, J., & Marx, R. W. (2000). Fostering Teacher Learning in Systemic Reform: A Design Proposal for Developing Professional Development. Paper presented at the National Association of Research on Science Teaching (NARST) 2000, New Orleans, LA.

Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a Theory of Teacher Community. *Teachers College Record, 103*, 942-1012.

Hmelo-Silver, C., Derry, S., Woods, D., DelMarcelle, M., & Chernobilsky, E. (2005). *From parallel play to meshed interaction:The evolution of the eSTEP system.* Paper presented at the 10th Computer Support for Collaborative Learning (CSCL), The next 10 years, Taipei, 2005.

Lave, J., & Wenger, E. (1991). *Situated learning : legitimate peripheral participation*. Cambridge, MA: Cambridge University Press.

Martindale, T., Trey. (2005). Using Weblogs in Scholarship and Teaching. *TechTrends, 49*(2), 55-61.

Miles, M. B., & Huberman, A. M. (1984). *Qualitative data analysis: A sourcebook of new methods*. Beverly Hills: Sage Publications.

Moore, J., & Barab, S. (2002). The inquiry learning forum: A community of practice approach to online professional devleopment. *TechTrends, 46*(3), 44-51.

National Research Council. (1998). *National Science Education Standards*. Washington, DC: National Academy Press.

National Research Council. (2000). *Inquiry and the National Science Education Standards*. Washington, DC: National Research Council.

Palincsar, A. S., Magnusson, S. J., Marano, N., Ford, D., & Brown, N. (1998). Designing a community of practice: Principles and Practices of the GIsML community. *Teaching and Teacher Education, 14*(1), 5-19.

Poling, C. (2005). Blog On: Building Communication and Collaboration Among Staff and Students. *Learning and leading with technology, 32*(6), 12-15.

Richardson, V. (2000). Searching for a Center. *Teaching and Teacher Education, 16*, 905-909.

Schlager, M. S., & Schank, P. K. (1997). Tapped-in: A new on-line teacher community concept for the next generation of internet technology. In R. Hall, N. Miyake & N. Enyedy (Eds.), *Computer support for collaborative learning* (pp. 231-240). Toronto, Canada: Author.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge, MA: Cambridge University Press.

Xie, Y., Ying. (2005). Students' Lived Experience Of Using Weblogs In a Class: An Exploratory Study.

Zembal-Saul, C., & Avraamidou, L. (2002, April 7-10). *Exploring the Influence of Web-Based Portfolio Development on Learning to Teach Elementary Science.* Paper presented at the National Association for Research in Science Teaching, New Orleans, LA.