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Using Action Research to Develop Preservice Teachers' Confidence, Knowledge and Beliefs about Technology

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Abstract

Involving future teachers in action research projects along with professors and/or teachers may provide opportunities for future teachers to develop content pedagogical knowledge, examine beliefs about teaching, and gain confidence. In this study, we focus on changes in the beliefs, knowledge, and confidence of 10 preservice teachers engaged in action research with a biology professor, a teacher educator, and a high school biology teacher to evaluate a National Science Foundation-sponsored project over a two-year period. The purpose of the NSF project is to enhance case-based learning in high school and university biology courses worldwide through the use of molecular biology computer simulations and Internet conferencing. Our results showed that engaging preservice teachers in action research studying the effect of case-based multimedia learning promoted reflection on beliefs about interacting with and monitoring students in computer lab situations, as well as dispositions of teachers. In addition, preservice teachers reported gaining confidence and developing more complex technological pedagogical content knowledge.

There are many barriers to successful technology integration but one of the most difficult to change is the mindset of the teachers and their deeply held beliefs about the nature of teaching, learning and technology itself (Sandholtz, Ringstaff, Dwyer, 1997). Preservice teachers have several misconceptions concerning educational technology, such as these beliefs (Young & Znamenskaia, 2001):

(a) it is ideal to have one computer for every student;
(b) the primary purpose of the Web is for research;
(c) students need a quiet working space to use the computer effectively; and
(d) the major portion of the computer expense is in the cost of hardware.

We know from research in science education that conventional pedagogy has little influence on changing beliefs, particularly the misconceptions of students, and that students tend not to alter beliefs even when presented with scientifically correct explanations (Nespor, 1987; Posner, Strike, Hewson, & Gertzog, 1982). Social interaction plays an important role in changing students' conceptions (Solomon, 1987; Lundeberg & Moch, 1995). In addition, personal experience and experiences with schooling may affect the development of beliefs more than formal pedagogical knowledge gained from courses (Richardson, 1999).

Keating and Evans (2001) found that although preservice teachers felt comfortable with technology in their daily lives, they expressed reservations about using technology in their future classrooms; that is, they lacked "Technological Pedagogical Content Knowledge" (p. 1). Keating and Evans built upon Shulman's (1986) idea of pedagogical content knowledge, that is, going beyond knowledge of subject matter content to a knowledge of how to represent subject matter to develop understanding in students. Thus, Keating and Evans write that "technological pedagogical content knowledge extends beyond proficiency with technology for personal use to an understanding of how technology can be integrated with subject matter and the technology itself.… The teacher understands the…inevitable challenges that accompany any new technology." (2001, p. 2). It is not the technology itself, but rather the way in which future teachers use the technology that has the potential to change education (Carr, Jonassen, Litzinger, & Marra, 1998). For example, when rating the effectiveness of multimedia, preservice teachers focus on superficial properties of the slides (e.g., color, graphics), rather than on the quality of the content and relevance of the information (Young & Znamenskaia, 2001). In a 1995 study, the Office of Technology Assessment (OTA) found that teachers are reporting little use of technology and most teachers lack confidence to use technology effectively even though there is a greater availability of technologies in schools.

Beliefs regarding one's knowledge to effect student performance (teacher efficacy) or to perform certain tasks (self-efficacy) are sometimes referred to as confidence. Confidence in understanding knowledge is a form of metacognition, that is, thinking about one's thinking. Self-assessment of knowledge is a primary component in academic learning. If students do not feel confident in their understanding of a concept, they can devote more time to learning the concept; if they are confident in their knowledge, they can attend to more difficult concepts. Previous research on confidence has shown that judgments of knowing accurately predicted subjects' recall retention (Leonesio & Nelson, 1990), and indicate cultural differences in confidence (Lundeberg, Fox, Brown, & Elbedour, 2000). In this study we asked preservice teachers to estimate their knowledge of biological concepts, as well as their confidence in using multimedia effectively in future science classrooms (teacher efficacy) using judgments-of-knowing measures.

The primary purpose of this research was to investigate whether involving preservice science teachers in evaluating a case-based multimedia collaborative learning project affected their beliefs about technology integration, developed their Technological Pedagogical Content Knowledge, and/or enhanced their confidence in using technology. Action research is systematic inquiry or problem posing by teachers, usually focused on promoting changes in practice (Cochran-Smith & Lytle, 1999; Henson, 1996). Action research is a valuable method of examining teachers' practices in Great Britain, Australia, and the United States (Cochran-Smith & Lytle, 1993, 1999; Elliott, 1990; Elliott, 1991).

In the past decade, action research has been advocated for both preservice and inservice teacher education as a means of improving teaching and learning through critical reflection on problems in practice (Gore & Zeichner, 1991; Lieberman, 1986). In the context of school-university partnerships, teacher action research has contributed to inquiry about pedagogical changes teachers are implementing (Catelli, 1995; Lundeberg, et al., 1995), as well as reform efforts (Lampert, 1990). The reflection involved in writing about classroom problems interwoven with the social interaction and multiple perspectives of other researchers may have a powerful influence on the development of preservice teachers' beliefs, knowledge, and confidence.

Method

Context of the Study

At the university level, this research was conducted primarily within a collaborative teacher education/biology seminar over a two-year period with 10 preservice teachers who were preparing to become secondary science teachers (five students were involved each year). These preservice teachers (five males and five females) assisted a biology professor, a teacher educator and a high school biology teacher in examining the effectiveness of a case-based multimedia Internet project within the context of two high school biology courses. Students received either biology credit or a small stipend ($500) for their participation.

The majority of the high school students on whom we focused our inquiry were juniors or seniors. In the first year of the project the high school teacher implemented this project as an “extra credit” project; in the second year, he included it as part of the curriculum. In year 1, we focused our research more globally collecting general data about the entire high school class; we also collected data from the college students in introductory biology who were using the case-based multimedia Internet project to communicate with these high school students. We decided to focus our investigation in year 2 on the high school students and to expand data collection in year 2 to include written case studies about each of the high school groups engaged in the project.

Description of the Project Preservice Teachers Evaluated

Case It! is a National Science Foundation-sponsored project initiated by participants in the BioQUEST Curriculum Consortium. The goal of this project is to enhance case-based learning in high school and university biology courses worldwide via molecular biology computer simulations and Internet “poster sessions.” Students first play the roles of laboratory technicians as they analyze DNA sequences associated with particular cases and construct Web page posters giving results of genetic testing. These cases include a problem situation faced by a family who decides to seek genetic testing to determine if one or more family members has a genetic disease. After students analyze the results of their genetic testing and do research on the disease, they then play the roles of genetics counselors and family members as they ask and answer questions concerning these tests. To accomplish this, students use three software tools: Case It Investigator to gather background information, the Case It simulation to analyze DNA, and the Case It Launch Pad to access a Web page editor and Internet conferencing system.[1]

Although the Case It! simulation works with any DNA sequence, we have concentrated on human genetic disease cases because of the high degree of student interest in these cases and ethical ramifications which make them particularly well suited for spirited discussion and debate. Students play the role of genetics counselors when responding to questions sent to their own group’s forum; they play the role of family members when sending messages to other groups’ forums. A host of issues can be discussed at these “counseling sessions,” including questions regarding the molecular biology of the disease, symptoms, treatment, and ethical issues that might arise. For example, if Susan talks her brother John into being tested for Huntington’s disease, and if Susan tests negative but John tests positive, how would the genetics counselors deal with the hard feelings that might result? If a fetus tests positive for sickle-cell disease and the family member asks about the possibility of an abortion, how should the genetics counselor respond? Cases developed and class-tested to date include Alzheimer's disease, breast cancer, sickle-cell disease, muscular dystrophy, cystic fibrosis, phenylketonuria, Huntington's disease, and fragile-X syndrome.[2]

Procedure

Preservice science teachers participated in a weekly seminar in which they read literature about multimedia simulations in science, gained experience with the Case It! software and then observed and collected data in a high school classroom. On the first and last days of the seminar preservice teachers completed a questionnaire assessing their confidence and knowledge in understanding biotechnology content and in using interactive multimedia in science. In addition, they wrote pre- and post-essays, giving advice to a science teacher who was considering using a multimedia Internet project. Beliefs can be inferred by what preservice teachers say, intend, and do (Pajares, 1992), and have been investigated using questionnaires as well as qualitative measures (Richardson, 1996).

In both years of the seminar these preservice teacher/researchers participated in designing the instruments used in the study, including the interview questions, and the rubrics used to assess the Web posters and the quality of Internet conferences. In the seminar, as a group, they analyzed data collected from the previous year to gain experience with coding interview data, rating Web posters, and coding interactions from Web conferencing. In the first year these preservice science teachers collected and analyzed data after the project was completed. They analyzed 30 Web posters (15 from college students and 15 from high school students), 60 Web conferencing interactions (30 college and 30 high school students) and interviews with 24 high school and 25 college students (49 total). In the second year of the project, we decided to focus our research on the high school students, which included 8 groups of 17 students ranging from sophomores to seniors.

We expanded data collection in the second year to include pre and post case-analysis assessments of the high school students and daily observations by at least two researchers, who recorded their observations and reflections electronically on a discussion site using Blackboard software. The discussion site included a forum for observations of the class as a whole with a focus on what the teacher (and student teacher) were doing during class, eight forums for observations of each of the eight high school groups within the class as they were engaged in working on this multimedia project, and a forum for research assistants to discuss reflections, concerns and questions. Each preservice teacher observed and wrote two case studies about four high school students (two groups) over a month-long observation period. The case study included what high school students did (and did not) learn, the challenges and difficulties high school students and the high school teachers faced, and whether this multimedia project was effective in enhancing student construction of knowledge. Cases included excerpts from interviews with the high schools students, excerpts from students' Internet posters and conferencing sessions and observations of the students' working process as recorded in the Blackboard observations. Finally, preservice teacher/researchers reflected on what they learned as a research assistant in this project.

In year 1, the Internet conferencing was between university and high school students in the United States. In year 2, the conferencing was expanded to include first-year university students in England and high school students in Australia. All students were taking a biology class (upper level at the high school level and introductory at the college level).

Data Analysis

Analysis of the data from the preservice teachers is based upon an examination of the beliefs that emerged as students constructed cases based on their observations, interviews of high school students and teachers implementing this case-based multimedia project. We also examined the beliefs and technological pedagogical content knowledge by comparing the themes evident in preservice teachers' pre- and post-essays giving advice to a teacher contemplating incorporating a multimedia Internet project into his or her science curriculum, and these preservice teachers' reflections on what they learned from participating as teacher/researchers in this project. Categories of analysis for preservice teachers' written cases and the open-ended essays were constructed by following Strauss and Corbin's (1990) approach to grounded theory generation. Finally, we looked at statistical changes in students' confidence as measured by pre- and post-questionnaires assessing confidence in understanding scientific concepts related to bio-genetics (six items) and confidence in using multimedia simulations as a future science teacher (six items).

Results

According to our research, engaging preservice teachers in action research studying the effect of case-based multimedia learning prompted the development of "expert views" of educational technology, beliefs about interacting with and monitoring students in computer lab situations, beliefs about the kind of teacher dispositions necessary for effective use of multimedia, and beliefs about the importance of finding user-friendly, "real-world" projects to engage students in higher-order thinking. In addition, preservice teachers developed more complex technological pedagogical content knowledge with regard to assessing complex projects such as CaseIt!, developing more complex views of the role of the teacher in using case-based technology projects, and challenges inherent in integrating technology into the curriculum. Finally, preservice teachers reported gaining confidence in their content knowledge of biotechnology and technological pedagogical content knowledge regarding integrating technology projects into their future science classrooms.

Beliefs Regarding Technology

Table 1 summarizes each of the belief categories described below along with the preservice teachers' new or altered beliefs that emerged through observations, interviews and their experiences implementing the case-based multimedia project.

Table 1

Beliefs That Emerged From Observations, Interviews, and Classroom Experiences

Belief Category	Description of new or altered belief
Misconceptions altered	Internet can be used for more than research. 1 computer per student is not necessarily ideal. Students can work effectively in noisy labs.
Monitoring student work	Closely observing computer screens and listening to pairs talk about their work is important. Teachers need to interact with students as they work.

	Facilitation of understanding through questions is more valuable than just giving answers.
Multimedia projects in science	Enhance thinking and understanding of ethical issues. Motivate students to work hard . Make science more relevant to "real life."
Teacher dispositions	Being prepared, collaborating with colleagues, being flexible, expecting challenges, recognizing that change is time-consuming, reflecting on student perceptions of new projects, and refining new projects are important dispositions in teaching.
Technological Pedagogical Content Knowledge	Preventing plagiarism from the Web is vital. Assessment of multimedia projects is complex and should be made clear to students through rubrics.

Misconceptions in the literature

None of the misconceptions identified by Young & Znamenskaia (2001) were evident in preservice teachers' cases or reflective essays after the end of the project. At the end of the semester, preservice teachers had developed an "expert view" of several aspects of educational technology according to Young & Znamenskaia's (2001) rubric. Specifically, preservice teachers had experienced the use of the Internet for constructing Web pages, sharing research projects and conferencing with people from other countries, so they knew the Internet can be used for more than research. These preservice teachers had observed and reflected on the value of pairs of students working collaboratively on one computer, so they knew it is not necessarily ideal to have one computer for every student. Finally, they expressed surprise at how focused students were in the computer lab even when it was crowed and noisy with students from more than one class all together, so they understood that students do not need a quiet space to use computers effectively. However, other initial misconceptions surfaced during the investigation.

Beliefs about monitoring students' work in the computer lab

During the open blackboard discussion in responding to the thread on "concerns, questions and observations about being a research assistant" three of the five preservice teachers reflected on how "intrusive" they felt closely observing students' work at the beginning of the project. This thread was started by one of the research assistants who had little experience with such different roles for the teacher—observing and listening rather than talking. He wrote:

> I found out today that I felt very intrusive at times while observing. I didn't feel I belonged there unless the students "invited" me in by asking a question or something like that. I wanted to be close enough to see and hear what they were doing, but didn't want to annoy anybody. Did anybody else feel that way, or am I goofy?

Two other research assistants assured him he was not alone in feeling that way and suggested how they had overcome this feeling. Three responses to his thread included:

> —I agree. I really felt that way also until I started going up to the groups and introducing myself. I felt a lot better about sitting back and doing my observations after I had a conversation with some of the groups so they knew who I was and why I was there.
>
> —That's sort of natural in a way. I even feel a little intrusive. I feel like their thinking "who's this guy?" But just throw yourself into it. Often by being open the students will open up towards you. It is tough.
>
> —I think if you informally chat with the groups; ask something like "how is it going?" they may ask you a question or you may feel more comfortable. You will feel better with practice too. If possible, "ask how did it go?" or "What did you work on today" just before they are asked to quit--around 8:40-8:45.

These research assistants were initially under the false impression that just glancing at students working can inform teachers about the quality of students' computer work, and commented in final reflections about the importance of carefully reading and monitoring student work in computer labs. As this preservice teacher said in his final reflection on the project:

> I was a little nervous in the classroom at the high school. I felt that I was being intrusive by standing over them (students) and looking over their shoulder, yet I overcame that and started to understand what each was doing and going through.

The importance of interaction with students

Although theories of social construction of knowledge had been presented to students and modeled by professors in earlier foundations courses, students' reflections showed they had not internalized some of this information until they saw it illustrated in the context of this science course.

A misconception related to the one on monitoring was that by just observing a student and not interacting you can know what is going on. This preservice teacher realized that her first impressions of a student based just on observation was mistaken after reading others' observations based on interaction with the student that were posted on Blackboard:

> After reviewing the blackboard observations about the Alzheimer Group, I realized that the other NSF research assistants saw different things than I did. For example, other observers noticed that K. seemed very interested in the project. Apparently his grandmother had a special case of Alzheimer's and he was very intrigued to learn more about the disease. In my initial personal observation, K. did not seem interested in the project. He appeared to be staring at the computer screen in a daze. It shocked me to read that K. was talkative to other NSF research assistants about the case and that he showed genuine interest in the assignment. If blackboard were not available during the observation process, I would have had a totally different perspective on this student's attitudes towards the project.

A second misconception regarding interaction that was initially held by one preservice teacher was that teachers should answer questions directly, rather than act as facilitators. As this preservice teacher reported,

> While at the school, I learned that when students have a question, it is more effective to give them direction in looking up the answers, rather than just giving it to them. Although we were told this in Educational Psychology, I thought this wouldn't work because students would just get more frustrated but as it turned out, this was completely the opposite. They didn't complain when they didn't get the answer directly; they were thankful that they had an alternative to finding the answer. I most certainly will use this in my teaching.

This above example shows that students' personal beliefs/misconceptions are not affected necessarily just by information presented in an earlier foundations course or by the modeling that occurs in the foundations course. This student needed to see the concept illustrated in the context of a teacher working with students in her own discipline for her to believe that it would "work".

Beliefs about the value of real world authentic projects to motivate students and enhance their thinking skills

In terms of advice on pedagogical methods, in their initial essays preservice teachers recommended using technology because it was new, interesting to students, and students need to develop technology skills for future jobs and college—in other words, technology for the sake of technology. In their later essays, preservice teachers discussed the importance of finding relevant tasks for students to use that will increase their higher-order thinking, enable students to connect science with everyday life and promote interactions through Internet conferencing focused on ethical issues. For example, this preservice teacher focused on promoting higher-order thinking:

> The primary reasons for using multimedia and Internet conferencing should be to enhance the thinking skills, and instruction of the students. The simulation should be student centered and have a lot of independent learning involved.… When using conferencing you also give students a larger view of the world when they conference with people outside of their school. It is a great benefit to students to do a multimedia project to learn technology skills, to communicate with people from other places about their topic and to think independently.

Another preservice teacher concurred that her research showed students thought more with technology projects such as the one she observed than with traditional lectures:

> According to the research I have done, I believe using multimedia simulations, Internet conferencing, and Internet use in the classroom can be a fun and rewarding experience for both the class and the instructor. The use of these technologies lets the instructor leave the everyday monotony of lectures, readings, and daily assignments behind.… For instance the Case It! Project helped students learn more about genetics, computer skills, communication skills, team work, and biology in general in a different kind of way. The students got to explore things for themselves (Internet searches), be creative (web pages/posters), and help other students learn (conferencing). I think this kind of activity helps raise interest, creativity, and thinking and learning skills. It is more interesting for students if they are allowed to discover the concepts for themselves rather than listen to it in a lecture.

The majority of preservice teachers discussed how this multimedia project motivated students' interest through "real life" connections with science content:

> While researching, I say what students liked dealing with real life issues…things that were relevant to their lives. They got to thinking that, "Hey, this could happen to me or someone I know." It really helped them get interested in genetics and science and maybe learn a thing or two more than with regular lecture-like situations. It seems this project has helped women get interested in science more, because it included them. It pertained to them and their lives. Science has normally been targeted at men, but now-a- days, it includes women more and more and I think this sort of project helps them realize that.

Several preservice teachers also wrote the value of making science content relevant to students' lives, such as this excerpt illustrates:

> One thing I found interesting after reading K. and A.'s web poster was that K. had added a personal reflection discussing how it felt to have his grandmother be affected by this disease.… that revealed he truly did enjoy this project and wanted to incorporate some of his personal experience in it.

Finally, this preservice teacher commented on the ethical/social elements coupled with the investigation that prompted deeper understanding in students:

> I think that the Case It! project is very valuable because it not only introduces a realm of molecular biology, but it also really gets the students to investigate and truly understand the biology involved. It also has huge social/ethical impacts considering that in the near future genetic testing may possibly be the norm. Using the role-playing element and conferencing option just furthers the opportunities for students to internalize the impacts of the project. It isn't just independent research that stands alone as a web-page, but group and individual accountability with analysis.

Beliefs about teacher dispositions

Initial essays lacked reflections on dispositions, or attitudes necessary for effective use of multimedia. Final essays, however, included much advice on pedagogical dispositions. For example, students wrote about the importance of collaboration with colleagues, being well-prepared, organized, and flexible, expecting challenges, recognizing that change is time consuming, and acknowledging that good teaching requires refinement and feedback from students. For example, one preservice teacher wrote:

> As far as pedagogy is concerned, I think that this is another thing which a teacher works out as he or she experiments with the project. Different classrooms will have different needs, and the simulation should be set up to meet those needs. The teacher can determine what the students' needs are by receiving some kind of feedback at the end of the project.… I think it's a really good idea to receive feedback from the students to determine how a multimedia program can be improved from year to year. The teacher must also reflect each year, after

> completing the project, on what he or she felt went the way the teacher wanted, and what needs to be changed.

In their essays, preservice teachers also showed a more realistic picture of incorporating technology and the need to persevere and to incorporate changes each year. For example,

> —The first thing I would tell a teacher looking to implement a multimedia simulation and internet conferencing into his or her classroom is that it takes time. More than likely, everything will not go perfectly the first year the teacher tries it, but as the teacher learns what works and what does not work year by year, the project will get better and will become a more effective tool which students can use to learn biological concepts…
>
> —A new teacher implementing a program like this should not get discouraged if things do not work out the way he or she had expected the first year or the first few years. As the teacher refines what he or she wants from the project and becomes more accustomed to the program themselves, the teacher will have a better idea of the expectations he or she has for the results of this project.

Changes In Technological Pedagogical Content Knowledge

In contrast to their initial essays which contained an average of 176 words, their post-essays contained an average of 676 words. Initial essays were vague whereas in their final essays students gave concrete, specific advice regarding rubrics for evaluating Web posters and Internet conferencing, and showed a more complex understanding of educational technology. For example, several preservice teachers began the seminar thinking that any use of technology would be great and ended by reflecting on the importance of the teacher in ensuring that technology is used appropriately. Their ideas showed more complexity in understanding when it is preferable to use "hands-on" science and when technology is preferable, rather than assuming that hands-on is always preferable or that any use of technology will enhance student learning.

Assessing complex multimedia projects

One of the students who had no advice regarding assessment in her initial essay wrote this on her final essay:

> As far as assessment issues go, I would advise a teacher that if he or she would like to implement web conferencing as a part of the simulation, the teacher will have to create some form of assessment based on web conferencing. Some students will want to conference simply because it is interesting to them, but if other students are not as interested, it can disrupt the entire conferencing system. There are always problems if some students are trying to conference and other students will not ask them questions or respond to questions they ask. My advice would be to make sure the students are fully aware of the fact that they will be graded based on how much they conference. This is not enough, however, as…learned early on. If students believe that their grade is simply based upon how much they conference, they will send dumb questions or comments just to get their names on the board. These types of interactions are not valuable to student learning. In order to encourage

> interactions that are extensive and incorporate deeper issues (such as moral/ethical or personal issues), the teacher must communicate to the students that their grade will be based upon quality of the interactions and not just quantity. The teacher should also define what he or she means by quality to the students. The teacher has to decide what he or she wants out of the interactions, for instance, whether it was important that students consider moral and ethical issues involved in genetic testing.

Preservice teachers recognized that assessment would be a challenge with a project such as this because "assessment is entirely different when students are learning in this manner." For example,

> Assessment is another challenge that has a lot involved. The most important thing in assessment is to be very clear. Decide exactly what you want to see from the students and make sure that they understand that. You need to decide your criteria for the conferencing. How many comments will be required of each student? What should the content of the comments be? You will also need to set up a rubric for the project. Have all points that you want them to learn listed and the expectations. You need to decide how to test their knowledge. Will you give them a test? Will you have them give a report? Will the conferencing give you enough knowledge of what they have learned? When deciding on assessment methods for your multimedia project you need to keep in mind what you want them to learn and make it clear to the students. While there are challenges to using multimedia the benefits can often outweigh them.

More complex views of the role of the teacher in using educational technology

In their initial essays preservice teachers were enthusiastic about using multimedia and did not include any challenges in their advice to their colleague (except for one who cautioned initially that "technology is not an end in and of itself"). Indeed some preservice teachers showed disdain for some of the reasons teachers use technology as this post-essay shows:

> Technology is only as good as the teacher who is using it and so for this scenario I am assuming that the teacher is interested in using it for the good of the students rather than to merely seem "up to date and innovative".

Reasons given for using technology projects in the final essays went deeper than simply to engage students in something "fun" or to be an "innovative" teacher. For example, preservice teachers wrote about carefully deciding and then explaining to students reasons for choosing an Internet project:

> Some multimedia project may have been done more successfully as hands-on projects. So be sure to tell students why you've chosen to give them an Internet assignment.

Others discussed technology as a means of providing more equity in education. For example:

> Technology can also be a means for leveling the playing field. As an economical alternative to costly lab equipment and field trips, technology can be used to introduce students to experiences far outside most district budgets. From sophisticated wet lab equipment in the

biology room to trans-global communication regarding various projects, modern technology has the potential to open doors in places where doors have never even been.

Several preservice teachers stressed how important the teachers' role was in effectively implementing technology. For example,

> —Accolades aside, however, teachers planning on using technology effectively must also be realistic. It is going to be a lot of work. From the introduction of the material to an effective assessment piece this requires one to think of education differently. To use technology effectively the teacher must also be comfortable with it first in order to encourage the students. The teacher must take the time to tailor lessons.…In this way they will be encouraged to really think about their own thinking and learning.
>
> —The human component in this equation in critical. Without the human aspect any technology amounts to no more than a machine taking up space and time in the classroom. In the hands of a true educator, however, it provides a variety of windows to the world, windows that brighten the future of all who look through them.

In their final essays, every preservice teacher discussed challenges inherent in incorporating multimedia Internet projects into the science curriculum. These challenges included time issues associated with scheduling Internet conferencing times with other teachers, plagiarism and technology glitches, for example:

> As with any project in the classroom there are time restraints that have to be put on the multimedia project. Time restraints can be frustrating and hard to schedule. If you are conferencing with another group outside your school scheduling becomes even harder. It's difficult to coordinate everything together with another school that has a different schedule. With different schedules you will need to decide whether to do real-time conferencing or not. The benefit of doing real-time conferencing is that you get responses quickly. The challenge to using it is scheduling. Another challenge with using multimedia projects is technology glitches. As soon as everything is going smoothly then something will crash. The key to getting around this challenge is to be flexible.

One of the problems that emerged during the Internet conferencing was plagiarism. The student teacher at the high school we observed spoke directly to this potential problem, telling students to cite their resources and to paraphrase rather than cut and paste from other Web pages. However, the group of students analyzing the breast cancer case came across another group of students at a different high school who had copied parts of their Web poster. The two groups were not assigned to conference with one another, but each group had access to everyone's posters and were encouraged to read additional Web posters other than their assigned ones. This event was written about in Blackboard:

> A. and K. had a fairly eventful day. They looked at a poster from…High and found out that some of the information may have been plagiarized from their own poster…some stuff was copied word for word. They sent a message to the group to see what was up. We'll see what happens. A. said something kind of interesting about the whole situation. He was obviously

> mad, but he said, "Maybe we can take this as a compliment." That they copied their information.

The message that A. and K. sent to the other high school group during Internet conferencing was this:

> Fellow Breast Cancer Researcher
>
> Wed, May 9 2001 07:50:09 AM
>
> I find it very ironic that you have quite similar information on your web page that we do. In fact, it is almost in the same order. Do you know what you are actually writing about, or are your plagerizing your information? Do you know anything about the actual treatments? What is Tamoxiphen and how does it contribute to the treatment of the breast cancer? Your statistical data is the SAME as ours.

After interviewing A. and K. about their experience with the project, the preservice teacher wrote:

> It seemed that the only negative thing they experienced during the Case It! project had to deal with plagiarism. Apparently some group had the majority of the same material, in the same order, on their poster as A and K had in theirs. Personally, I thought that this was a great experience for them because they now understood how it feels to spend a great deal of time on something and have someone copy it verbatim. In his interview, A. mentioned that, "all our lives teachers have preached to us about not plagiarizing." I think that they got first hand experience of what it feels like to have such a thing happen to them.

Confidence Gained By Preservice Teachers

Preservice science students who served as research assistants in the first year developed significantly more confidence in their knowledge of genetic testing from the beginning to end of the semester, $t\ (4) = 3.03$, $p < .04$. Biogenetics is an elective, but not required course in science teacher education at our university, so many of the preservice teachers did not have much background initially and had to learn quite a bit to be able to assess the high school students' posters. Research assistants also developed significantly more confidence in their knowledge of using multimedia as a future science teacher from the beginning to end of the semester, $t\ (4) = 3.81$, $p < .02$. None of the preservice teachers experienced multimedia Internet projects themselves when they had been high school students, nor had they observed much technology use in some of their earlier field experiences. Thus, they reported greater confidence in using technology in their future classroom after their experience as a research assistant in this project than on the initial questionnaire.

Discussion

Being a research assistant involved in an action research project with a high school science teacher prompted thinking, writing and conversations about some of the challenges and benefits of using case-based learning with high school students. These preservice teachers also thought and wrote much about some of their beliefs regarding implementing complex, involved multimedia projects into their future science classrooms and some of the technological pedagogical content knowledge they gained by their observations and study of students in this classroom.

There are many limitations to this exploratory study, including the limited number of preservice teachers involved, the response bias that likely affected some of the preservice teachers' thinking, and the context-specific nature of the study. Future research is needed to know if the results found here can be replicated in other contexts that involve preservice teachers in writing about and reflecting on cases of K-12 students learning, and/or being involved in studying the effects of an exemplary teacher making changes in his classroom. Reading, writing and discussing cases about teachers facing classroom dilemmas are used in teacher education because the classroom is so complex it may be difficult for beginning teachers to develop deep understanding from unstructured observations. However, some evidence suggests that writing a case about one's experience in a classroom enables a student to have repeated exposures to this case experience, and their representation of the case may change and develop over time (Hammerness, Darling-Hammond, & Shulman, 2002).

Although the majority of preservice teachers I have taught in the past have reported developing understanding from discussing printed cases, I have been disappointed when informally asking them about whether they planned to use cases in their future K-12 classrooms. Although preservice teachers have commented on cases being beneficial in changing their thinking, informal conversations with students who reported liking and learning from the case method in foundations courses showed that few students transferred the idea of using cases in their own content areas to promote the development of knowledge. In contrast, using a "bigger" case (Pressley, 1999), that is, a live case of a biology high school teacher making a change toward more constructivist, case-based teaching of high school students, seemed to enable preservice teachers to have a curriculum-specific context. Involving preservice teachers in studying the effects of change in this curriculum-specific context seemed to promote the development of beliefs, technological pedagogical content knowledge and confidence. Moreover, preservice teachers expressed plans to use case-based multimedia in their own future classrooms. Whether they actually do will require further research.

Notes

[1]The latest versions of both the Macintosh and PC versions of Case It Investigator and the Case It simulation are currently available for downloading, free of charge for educational use. These two applications are also part of the BioQUEST Library of inquiry-based software.

[2]For information regarding the creation of these cases, and the simulation students use to analyze DNA, see Bergland, et al. (2001). This article also describes in more depth the software tools that direct students to relevant Internet sites, and the launch pad that includes a Web page editor and organizes links to each group's discussion forum and published Web page.

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