Virtual Tutoring Pilot Program: Questions and Considerations for the Future

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Abstract

This case study describes a Virtual Tutoring (VT) pilot project funded through a National Science Foundation (NSF) Math Science Partnership (MSP) sub-award. The project investigated the efficacy of using internet and Smart Board technology to link university and secondary school students. The unique attribute of this project is that in addition to traditional goals of tutoring, in this case supporting high school students struggling in mathematics, further goals were to generate interest in the teaching profession among university student tutors and to stimulate high school teachers' thinking about the use of technology in teaching and learning. The project faced and overcame many obstacles: changes in school district personnel, difficulty in finding times when both tutors and tutees were available, a shortage of secondary students seeking tutoring, and many technical challenges. As documented by the project's ethnographer, this pilot project was generally deemed valuable by all involved, including tutors, tutees, teachers, and administrators. This study also pointed to the importance of better understanding the types of learning communities that can best be supported through online linkages between high school students and college students. The technical solutions and other lessons learned should be of considerable use to future projects of this type.

Key words: Online tutoring, university-high school partnerships, Interactive Mathematics Program, recruiting teachers

Introduction:

The Virtual Tutoring (VT) project was part of a university partner's sub-award within the Math Science Partnership of Greater Philadelphia (MSPGP), a project funded by the National Science Foundation (NSF). The project was based on the organizational strategy of linking partner entities together in a manner that makes the whole greater than the sum of its parts. One of the grant-wide program areas was the exploration of new technologies to achieve the main MSPGP project goals, which were to:

1. Ensure that all students have access to, are prepared for, and are encouraged to participate and succeed in challenging and advanced mathematics and science courses;
2. Increase the quality, quantity and diversity of pre-service teachers interested in pursuing math and science secondary education through more effective field experiences and recruitment activities;
3. Develop evidence-based outcomes that contribute to our understanding of how students effectively learn mathematics and science; and
4. Develop evidence-based outcomes that contribute to our understanding of how to achieve 6-12 institutional reforms to support the mathematics and science components of the preparation of 21st Century citizens.

While the specific goal of the VT project was to determine the efficacy of using technology to link university and secondary school students, projects such as VT have the potential to support all four of the above goals. The following theory of action which guided the project illustrates this point:

IF:

a) Hatfield (pseudonym) University faculty and students and high schools (teachers and students) work in partnership to support use of the Interactive Mathematics Curriculum, and
b) Hatfield students and high school students utilize the affordances of virtual technology

THEN:

a) high school students will learn more mathematics,
b) high school students will use virtual technology to explore mathematical concepts,
c) high school teachers will learn more about the teaching and learning of mathematics, especially in terms of the use of technology, and
d) college students may become more interested in teaching high school mathematics as a possible career option.

Background

Interest in online education continues to grow, and educational institutions have increasing opportunities for experimenting with a variety of synchronous and asynchronous communication channels, as well as increasing opportunities for experimenting with blending face-to-face and electronic communication. The potential for increased access to expertise as well as the potential for developing new types of collaboration are frequently assumed to be two ways that e-learning can revolutionize the nature of teaching and learning at many levels. For example, a summary of a recent report about online learning posted on the Blackboard learning system website concludes: “As online learning becomes more integrated into day-to-day instruction, the compartmentalization of education breaks down.” (Net Day: Speak Up 2006 and Blackboard, 2007). To address just this issue, this project was explicitly designed to build a bridge between high school and university communities.

The e-learning literature also describes an increasing awareness of the wide range of variation in purposes, structures, and participants in e-learning. In a 2005 concept paper about effective evaluation methods for e-learning, Ellen Mandinach noted that e-learning “is being conducted for many reasons and often without a clear specification of its educational objectives…. Is its purpose to make money, save money, enhance learning, increase accessibility, improve instruction, or something else?” (p. 2). It is widely recognized that effective implementation and replication will depend on identifying and assessing project-specific goals, contexts, and implementation processes (Bonk and Graham, 2004; Cavanaugh, 2001; Greener, 2008; and Knolle, 2002). As the research about e-learning becomes more sophisticated, there is also increasing attention paid to how particular types of online formats and activities interact with or contribute to particular pedagogical goals (see for instance Greener, 2008 and Russell, 2007). Given this need for articulation of goals, this project commenced with much discussion around its intended purposes and the structures for achieving them.

A scan of the literature about e-learning helps place VT in the larger universe of online learning and helps to identify potential lessons from VT’s pilot year. This review suggests that the growth of digital technologies means that young people are now growing up in a world that is shaped as much by electronic relationships as it is by face-to-face relationships. According to one current report, due to the impact of developing technologies, “the way we work, collaborate, and communicate is evolving as boundaries become more fluid and globalization increases.” (The New Media Consortium and the Educause Learning Initiative, 2008). This annual study of technology trends in higher education suggests that the 10-year “mega-trends” with the most momentum and relevance to the VT project are:

- the use and growth of web-tools that support collective sharing and generation of knowledge, and
- the continued increase in the interpersonal connections through the network which has been fueled by wireless capacity.

The success of this project was dependent on tutors’ and tutees’ facility and comfort with online technology, at least to the extent of not interfering with effective communication and learning. Empirical studies of technology used by young people are consistent with the Horizon Report's analysis of increasing online connection (The New Media Consortium and the Educause Learning Initiative, 2008). A study of electronic communication and writing by teenagers reports that 94% of teens go online to use the Internet or email; 6 in 10 have a desktop or laptop computer, and 7 in 10 have a cell phone. 85% of teens use electronic forms of text such as text-messaging, email, instant messaging, and posting comments on social networking sites to communicate with friends and family members (Lenhart, et al., 2005). Another recent study finds that one out of five students in grades 6-12 has taken an online or distance learning course on their own or at school (Net Day, 2007). According to several researchers, teenagers and college students are so likely to take technology for granted that they have a hard time answering questions about how they use it (Lenhart, et al., 2005; Oblinger and Oblinger, 2005).

For this VT project, it was also important to consider how particular types of online formats and activities interact with or contribute to particular pedagogical goals (Greener, 2008; Russell, 2007). While it is clear that young people are growing up in a world rich in electronic connections, educators and researchers are still working to identify the pedagogies, course structures, and curricular materials that help to translate skills and dispositions learned in the virtual world into high quality teaching and learning in formal academic settings. For example, the study of teens and writing mentioned above indicates that teens want to write well, but 60% think of their online texts or text-messages as something very different from the "writing" that they do in school (Lenhart, et al., 2005). This suggested that it would be valuable to pay attention to whether the participants in this project saw the use of technology as serving the goal of learning mathematics.

A related study found that college students' immersion in a fluid electronic world encourages them to think visually, seek out interpersonal connections, and expect quick answers to their questions (Oblinger and Oblinger, 2005). Nevertheless, it is the quality of communication and interaction, not technology in and of itself that is important to college students: "It isn't technology per se that makes learning engaging for the Net Gen; it is the learning activity …. [S]uccessful learning is often active, social, and learner-centered." Appropriate uses of technology support these characteristics of successful learning, "but the uses of IT [must be] driven by pedagogy, not technology" (Oblinger and Oblinger, 2005).

The literature also suggests particular types of online formats and activities interact with or contribute to particular pedagogical goals (Greener, 2008; Russell, 2007; Shi and Morrow, 2006). Web 2.0 applications--i.e. applications that position users as collaborative generators of knowledge, rather than as information consumers--foster new norms and opportunities for the creation of knowledge. While this is an opportunity, it is also a challenge because, "more work is needed on the assessment side before the full potential of these kinds of activities can be realized…. The challenge faced by the educational community is to seize those opportunities and develop effective ways to measure academic progress as it happens" (New Media Consortium, 2008, p. 5).

Relating these themes to Hatfield's VT Project, we can identify several features that are valuable for assessing its potential contributions. First, it is an educational project that uses a variety of online tools (e.g., chat rooms, white boards, drawing tools) and channels (text, video, and audio) that are commercially available through Blackboard and Wimba. Second, and more importantly, it uses these tools to create a shared workspace that synchronously connects members of two existing face-to-face communities – one consisting of college students and the other consisting of high school teachers and students.

Identifying these features helps to clarify the similarities and differences between VT and other online tutoring services for K-12 students. Online tutoring is a proliferating business. Companies offering online tutoring utilize a variety of technologies and two-way communication channels including email, chats, white boards, microphones, and webcams. Like VT, each of these tutorial services is described as having well-trained tutors with expertise in the appropriate content available to provide individualized help to students in need. Each of the services is described as providing skilled, appropriately-paced, and student-centered tutoring, and at least one of the services (Kaplan) has tutors trained to work with reformed mathematics curricula including the Interactive Mathematics Program (IMP).

Another aspect of tutoring that has been addressed in the literature is the impact of tutoring on student tutors. Hedrick, McGee and Mittag (2000); McCabe and Miller (2003); and Baker, Rieg and Clendaniel (2006) endeavored to describe such impacts as changes in student attitudes, self-concept and pedagogical awareness. In their literature review on peer and cross-age tutoring in mathematics, Robinson, Schofield and Steers-Wentzell (2005) noted several studies that reported increases in tutors' own performance of the specific mathematical concept they were tutoring. For example, tutors who were tutoring students in geometry were gaining in that domain; however, they were not gaining in other mathematical domains. These findings are of special interest in the VT project because its value proposition extends not only to the tutees but also to the tutors, and even to the teachers.

The biggest difference between Hatfield's VT project and commercial tutoring services is the collaborative and mutually impacting nature of the activity. In most of the conventional tutoring programs, as in the commercial tutoring services, it is assumed that the student needing remediation is the person who is changing. In contrast, VT was structured to explore the potential of online relationships to facilitate learning and change among the high school students (who needed additional support in IMP), college students with math-related majors (the tutors) and high school math teachers (who provided technical, logistical, and curricular support to tutors and tutees). Student success in mathematics (MSPGP Goal 1) was supported in two ways: one, directly, by impacting the students; and two, indirectly, by impacting the teachers and tutors. Students received the benefit of the tutoring, while their teachers had an opportunity to observe the students interacting with the college tutors and to reflect in such a way as to experience a potentially positive impact on their own teaching. This impact on the teachers supports MSPGP Goal 2, which focuses on expanding the quality, quantity and diversity of mathematics and science teachers. That goal was further met by the fact that this program piqued the college student tutors' interest in becoming mathematics teachers.

To support the multiple levels of potential impact, VT was designed so that participating teachers and high school students would work together at a particular time in a particular computer lab. Similarly, participating tutors would work at the same time in a computer room at the college. One purpose for synchronous physical locations was to structure the project so that classroom teachers could be engaged as teachers (supporting tutors and tutees working with reform mathematics) and as learners (thinking about mathematics instruction). Similarly, when participating college students were in a shared space at the same time, they were able to work together in exploring the technology and to help each other in the process of tutoring.

In contrast, despite some attention to professional development, commercial tutoring services are primarily structured as supports for individual tutees. In the commercial tutoring programs, tutors and tutees have one-on-one interactions that are usually scheduled at the convenience of the individual student and his or her parents. These can use a range of synchronous or asynchronous communication channels, which vary depending on the provider.

As will be discussed below, after-school tutoring, even on-line tutoring, was not particularly enticing for most of the students who were asked to participate. Based on the low attendance during the pilot year, school staff offered a number of recommendations to build on the strengths of the program while avoiding some of the pitfalls. High attrition rates in after school programs for high school students are common and have led advocates to recommend that out-of-school time programs for older youth incorporate the principles of youth development, provide flexibility in scheduling and activities, offer a variety of high interest programs, and ensure that teaching methods are interactive and youth-led (American Youth Policy Forum, 2006; Hall and Gruber, 2007). VT's model was developed by mathematics educators, not specialists in after school programming, and did not incorporate all the features that are most likely to attract older youth. However, the model--which creates a common workspace with virtual and face-to-face components in order to catalyze new learning communities--is precisely one of the types of online interventions that educators and researchers are asking for. Future iterations of VT will undoubtedly incorporate different arrangements of physical, virtual, and human components. It is hoped that as adjustments are made, program developers will continue to focus on the importance of fostering collective, cross-role learning. As VT projects continue to evolve, it will also be important to remain alert to the subtle and not so subtle challenges and affordances that come along with situating virtual work spaces within the gritty reality of space and time in American high schools and institutes of higher education (IHEs).

The components of the VT project which focus on cross-role learning place the project within the field of collaboration within virtual environments. There is much excitement about virtual realities and gaming as a way of capturing young people's involvement in the online world. The VT project shows that a "shared virtual workspace" is another kind of application that can promote collaboration and creativity in a K-16 partnership.

How It All Unfolded:

Engaging the Schools

A retired mathematics teacher and MSPGP technology coordinator met with several MSPGP partners including those with expertise in instructional technology. Two professors from Hatfield University, one of MSPGP's thirteen higher education partners, decided to incorporate it into their university's sub-award.

After an abortive attempt to start the program at one school, the program restarted, with different partner schools: Morrisville (pseudonym) High School Ninth Grade Academy during summer 2007 and Mid-Atlantic Charter (pseudonym) during spring 2008. Both of these schools had adopted the IMP curriculum, with which the critical project staff had extensive experience both as teachers and workshop facilitators. Furthermore, the math coordinators at both schools enthusiastically welcomed the opportunity, as did their instructional technology departments.

Setting Up the Technology

Hatfield University was only able to provide audio and video internet access via Wimba media, which at the time of the inception of this project was only supported on the commodity internet. Therefore, all participants had to adjust to the slower speed of the audio and visual feeds than would have been possible through the Internet 2. In one case, the students at the remote high school location logged onto Hatfield's Wimba with access provided by the university. In the another case, the school had its own Wimba access through the Blended Schools Consortium and their IT staff preferred to have both tutors and tutees use this system. In this situation, the Hatfield tutors logged onto the remote school's system. At one point during the summer of 2007, tutors worked simultaneously with a student at one school on Hatfield's Wimba and with a student at another school site utilizing the Blended School access. This demonstrates the compatibility of both systems being used from different remote locations.

Designing the Research Project

Recognizing the potential value of VT as a pilot project, Hatfield University hired an ethnographer to study and document the project. The research project was initially guided by questions about impacts on high school students, high school teachers, and college students. As the project evolved, the research also changed to address questions about implementation and logistics. The research activities were not strictly ethnographic in nature, but the flexible approach to documenting this evolving project grew out of the project's interest in using ethnographic methods. The ethnographer conducted interviews with the three high school students who participated most consistently at Mid-Atlantic Charter, three participating high school teachers (one from Morrisville High School who participated during the summer of 2007 and two who were involved during the winter and spring of 2008 at Mid-Atlantic), and the high school administrator (the Teaching for Learning Coordinator) who took the lead in implementing the project at Mid-Atlantic. In addition, the ethnographer conducted baseline interviews with five university tutors, conducted a focus group with seven tutors involved during the late spring of 2008, observed informal tutor training-sessions, observed high school students and teachers at Mid-Atlantic during one online tutoring session, and reviewed archives and artifacts from other tutoring sessions.

Tutoring Sessions

The project started with a summer run-through of technology and training with Morrisville, involving three Hatfield tutors, one Morrisville teacher, and a single Morrisville tutee who participated sporadically. Since several of the tutors came from traditional high school mathematics programs, the project leaders felt it was important to help them understand the content and pedagogical strategies that underlie the curriculum with which they would be working. Consequently one Hatfield student tutor was enrolled in a week-long IMP institute for teachers. There was a hiatus in program implementation due to a variety of factors, including changes in personnel at participating high schools. However, Mid-Atlantic Charter, which had not participated in the summer run-throughs, had a longstanding professional development relationship with MSPGP staff and was eager to get involved. Tutoring started at Mid-Atlantic in February and sessions took place for nine weeks with time off for the schools' spring breaks. VT took place at Mid-

Atlantic in a computer room adjacent to the library, and students were supervised by math teachers who were paid for this extra duty by the grant. The Hatfield tutors worked together in an on-campus computer lab.

Initially, tutoring was scheduled to take place two days a week at the end of the school day. The specific days were soon changed to because of scheduling conflicts. During the last two weeks of the program, there was also a plan to provide online tutoring in geometry (supervised by the librarian) during class hours of one of the participating teachers.

When tutoring began, six tutors were involved. Over the next eleven weeks, there was some turnover among tutors, with a total of twelve tutors having been on the payroll by the end of the semester. For the most part, tutoring was available for Mid-Atlantic students two days a week. In addition to being paid for tutoring hours, Hatfield students were asked to participate in paid training sessions several hours a week.

Two teachers (one IMP-trained, and one not IMP-trained) were identified to assist at tutoring sessions and be the liaisons with Hatfield. Fourteen students whose math curriculum included IMP were identified for participation. By chance, these initial students were not in the participating teachers' classes. According to staff interviews, these students were identified on the basis of their previous scores on the Pennsylvania State System of Assessment (PSSA) test. It was hoped that tutoring would help them move from "basic" to "proficient" on the PSSA and would also help with their ACT scores. Six of the students who fit this profile actually participated (one girl and the others boys). Towards the end of the project, one participating teacher identified several of his non-IMP geometry students whom he thought would benefit from participating in the program. Attendance was sporadic for many of the students, both IMP and non-IMP. According to interviews and observations, there were seldom more than three students, sometimes only one, and occasionally no high school students attended.

<u>Initial Reaction</u>

In short, the project was successful in overcoming technical difficulties and demonstrated the feasibility of university students using the Internet to tutor their high school counterparts. The major obstacle stemmed from the project's plan to offer after school tutoring to high school students, a plan that did not take into account the difficulty of attracting high school students to remedial after school programs. The school administrator suggested a few alternative proposals (see below) for the future; these suggest a variety of potential connections between VT and already existing high school mathematics classes.

Findings

The findings of this case study represent both the strengths and challenges of the VT pilot project as identified by the ethnographer and the project staff. The first section of findings relate directly to the four anticipated outcomes in the project theory of action, the second section presents other findings that emerged from this pilot study.

Anticipated Outcomes:

a) High school students will learn more mathematics

Due to the limited time the tutoring was actually in place and inability to gather specific measures of learning, this outcome was untested. The enthusiasm of the teachers and the administrator who worked most closely with the program, however, suggests that they felt the experience was effective in helping tutees learn mathematics. The administrator explained that participating students became more comfortable with using the language of mathematics possibly because the college students phrase things differently from teachers when they are asking questions. She illustrated this by describing a session she saw in which the students were doing problem-solving involving functions. While the students were speaking in terms of the specific numbers, the tutors were using language referring to the variables in the equation. Once the students saw that, it was easier for them to do the graphs and to move between graphs and equations. The administrator concluded, "*It's starting to close the math language gap. The kids here have a hard time explaining how they do their work. Explaining it* *to the tutor helps*." The administrator also felt that communication between the tutors and students was effective: "*the tutors were able to tune into where these guys were coming from* [*at the same time that*] *the students got used to how the tutors use language. The tutors always spoke in mathematical terms. They never reverted to the language of the kids.*"

b) High school students will use virtual technology to explore mathematical concepts

As described above, the high school students who did attend used the virtual technology to explore mathematical concepts. Students' use of technology was challenging, however, because hardware at Mid-Atlantic initially thought to be accessible only to the VT program was also used for other instructional purposes. Because of this, the Smart Board could not be left configured for VT after tutoring sessions. The staff and students adapted by using their desktop drawing tools instead. This was initially challenging because as the administrator noted, "*there's a level of ease on the Smart Board*."

The tutors found some of the high school students were more at ease with the technology than others. One tutor said that *"[This] generation now is basically growing up with this technology, and more and more I think they're getting more comfortable with this rather than person to person."* An interesting observation, however, was that the Hatfield tutors noted that some students avoided eye contact with the webcam. Even though one such student reported that he did not use technology very much, both the tutors and his teacher interpreted this more as an indication of social awkwardness than with his discomfort in using the technology for developing an understanding and facility with mathematical concepts. On the other hand, one young woman, a regular and engaged participant, was described by one of the teachers as follows: "*She has done a good job. She was good from the beginning. She came in, knew how to talk, ask questions*." In an interview, the student described herself as someone who liked technology and who was familiar with microphones and webcams used for VT. The Mid-Atlantic administrator, herself, expressed the belief that technology is so much a part of the technological world today that "*everyone needs to be used to [it].*"

Tutors also felt that the technological platform positively impacted tutees' attitudes towards mathematics. One observed that, *"[W]hen they do it on the computer it almost makes the mathematics seem less obsolete to them -- more pertinent to something they're interested in [such as] chatting, playing with the video, playing with the e-board."* The Hatfield tutors had mixed reactions, however, to some of the specific applications that they used in teaching mathematics. One tutor felt that the drawing tool that allows manipulation of a virtual pencil to draw freehand shapes impedes quick illustrations: *"It's more difficult, or takes more preparation 'cause … you have to draw it on the screen."* However, another tutor acknowledged the power of other electronic tools, such as pre-embedded geometric shapes for students to manipulate. For example, the student can see how many triangles will fit perfectly into a square the tutor has pulled up. According to the tutor, "*Somebody wouldn't have that on a blank sheet of paper. So it gave me more applications right at [my] hand."*

c) High school teachers will learn more about the teaching and learning of mathematics

Mid-Atlantic staff reported that they enjoyed learning about the technology, they generated many ideas about the future of such projects, and they believe that college students have a lot to share with high school students. In addition, the administrator indicated that teachers gained a better understanding of the mathematics that college students need, and that the teachers came to believe that college students have a lot to share with high school students. Specific impacts on their teaching of mathematics were not observed or described.

d) College students will become more interested in teaching high school mathematics as a possible career option

Interviews with the tutors provided evidence that the VT project did have a positive impact on the college tutors. The impact was felt not only as a result of the tutoring itself, but also as a result of preparation for the tutoring.

First, the project provided tutors with the opportunity to envision themselves as future teachers. One tutor commented, *"[T]o me it's . . . an insight to the possibility of how teaching can be, or is going to be by the time I might be teaching."* Another said, *"It's been great for me because it's given me that much more experience on whether I want to teach or not."* A third quipped, *"I got to try teaching out [by] being a high school math teacher for the day. That was awesome."*

In addition, all five Hatfield students who participated in interviews reported that the project exposed them to ideas about the teaching and learning of mathematics that were different from what they had experienced themselves. Two students who were taking a mathematics education methods class commented that the project was exciting and different from what they learned in their education courses. A third, who had been discouraged from becoming a math teacher by her family, was rethinking the possibility. The project provided college tutors with an opportunity to strategically think about pedagogical strategies. One who had an opportunity to attend a week-long training session with teachers commented that it was "*like taking a plunge into teaching*" and observed how interesting it was "*to be on the other side [and] hear the teachers discuss all the different teaching methods."* Additionally, three tutors spoke enthusiastically about their connection with a participating teacher and student over the summer. They met with the teacher face-to-face, felt they understood her approach to teaching, and explored the use of the technology together with her even when the student was not present. One of the tutors said, "*It was really great about [the teacher]. She constantly gave us the lesson plan for the week. We knew exactly what she was doing, where she was going, and how it was going to connect to the thing that she was going to teach.... She also tells us, 'Make sure that you don't do it this way. I don't want [the student] to know about this yet.' ....We would work with her, rather than against her."*

Another contributing factor was that the tutors responded to the fact that they were considered equal partners in the project: *"[We] like being involved in the project development. … [We're] not just [being expected to] show up and tutor and [be told] … what to do. [W]e've really been involved in the project; it's nice."*

Other Findings:

1. **Hatfield students were enthusiastic about the potential of the project, although logistics limited the extent of their involvement.**

   All students interviewed report that they were motivated when they heard about the program. The tutors who were involved during the summer were also excited about identifying and exploring the capacities of Blackboard (the drawing tools, the backgrounds, math tools, visuals, etc.). Many of the capacities discovered by the tutors were subsequently used during tutoring sessions with Mid-Atlantic students. Later, though, some of the college students quit the VT project when they did not have the opportunity to do actual tutoring because of the challenge of scheduling the high school students. One stated that, *"People are motivated when they hear about the program but when there aren't students, they drop out."*

2. **Initial technological issues were successfully addressed, but challenges around technology point to the attention that must be given to the social and physical relationships in which the technology is embedded.**

   The tutors experienced some frustration with not having administrator controls over some of the software and felt that they would be able to do more with the software if university staff responsible for the computer lab were more aware of the needs of the project.

   There were some challenges that the tutors experienced in establishing a working relationship with the tutees as evidenced by the webcam shyness mentioned above. The assumption that this was an issue of self-confidence rather than technological awkwardness was not tested; however, whatever the cause, it did not appear to significantly impact communication between tutor and tutee.

   At times, though, the tutors felt that the technology hindered a natural flow of communication. One experienced tutor, comparing VT to person-to-person, said:

> *It's completely different ... so much harder. … I think tutoring is very easy when you're with someone side by side so you can see their facial expressions. And … on the computer it's just harder to … explain everything. And … you can't just pick something up and draw it … You have to draw it on the computer and … it tends to be harder.*

3. **The connection between IMP and the processes of VT needs further exploration.**

   It is not clear to what extent Mid-Atlantic students focused on practice for the PSSA's and to what extent they worked on problems from the IMP curriculum. Geometry tutoring was also added later, but not observed by the ethnographer. The Mid-Atlantic administrator noted with satisfaction that the students were more interested in geometry and IMP than in test preparation. Several Hatfield students commented that IMP exposed them to a different approach to learning math, and they enjoyed tutoring it.

4. **There are several potential advantages of conducting a real-time, virtual tutoring program during the school day, as opposed to after-school, asynchronous or at home tutoring.**

   The Mid-Atlantic administrator emphasized that one of the key advantages of running the VT sessions as part of a partnership is that it provided opportunities for trust and relationship building between tutors and tutees: "*You can't lose the personal touch. There's mutual respect between the tutor and student. But one of the things that is different about VT than a correspondence course is that the kids have a connection with the tutor."* The Mid-Atlantic administrator also expressed her belief that VT has greater potential than math software products that are available for classroom enrichment: "*We've looked at the math software, but most of it is pretty limited. This has infinite possibilities*."

5. **The Mid-Atlantic staff had recommendations for continuing and refining the program in the future** for example: offering an accelerated after-school program for advanced students and/or integrating online tutoring into the actual math classes.

6. **There was a positive impact on the tutors own learning** by strengthening their mathematics content knowledge. One tutor explained that she was tutoring concepts she hadn't encountered since her own ninth or tenth grade mathematics class, and she was able to make connections between those concepts and her college mathematics course.

Limitations

Since much of this pilot program was focused on logistics, it is highly likely that this study has missed capturing some of the highest value lessons to be learned from such a project. These lessons would be focused on the nature of the interactions and potential transformations between tutors and tutees, among the tutors themselves, among the tutees themselves, between the teachers and tutors, and finally between the teachers and tutees. In addition, the small sample size limits the generalizability of the findings and conclusion.

Conclusion

As a pilot, this project was successful in demonstrating the feasibility of utilizing some of the available technology for VT. Furthermore, there are indications that the project's Theory of Action is worth continuing to explore in the future. That is, this pilot suggests that the first three anticipated outcomes can be attained and documented in future iterations of an on-line partnership:

a) High school students will learn more mathematics;
b) High school students will use virtual technology to explore mathematical concepts;
c) High school teachers will learn more about teaching and learning and of mathematics.

In addition, there is substantial evidence that the fourth outcome was met in the pilot:

d) College students became more interested in teaching high school mathematics as a possible career option.

Whether the lack of more substantial evidence was due to the scope and challenges of the project, limitations in the research, sample size or inherent weaknesses in the underlying theory is difficult to determine. That being said, a number of findings clearly demonstrate the effectiveness of this project on multiple levels.

Typical of a good pilot project, many new questions emerged. These questions fell into four primary areas:

1. How can program logistics be changed to improve participation by K-12 students and college tutors?
2. How can the impacts on K-12 students and college students be better identified and measured?
3. Are there other pedagogical strategies such as mentoring, partnering, or asynchronous chat rooms that could be combined to increase the effectiveness of achieving all four goals of such a project?
4. What aspects of technology are most important to continue exploring (e.g., audio, individual text chat, shared chat rooms, Smart Screens, Smart Boards, webcams, email, archives)?

Other questions focus on more substantive aspects of the virtual model itself.

Perhaps most important is the consideration of the unique contribution of this kind of partnership to creating a learning community. Online, synchronous tutoring is becoming increasingly pervasive. It is essential to consider whether the goal of VT is to provide the same types of services that are being provided elsewhere through vendor relationships, or whether there are unique opportunities for VT within a K-16 partnership.

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