Student Adoption of a Computer-Supported Collaborative Learning (CSCL) Mathematical Problem Solving Environment: The Case of The Math Forum's Virtual Math Teams (VMT) Chat Service

By

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A dissertation submitted in partial fulfillment of
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We hereby certify that this dissertation, submitted by Ilene Litz, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.

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Numerous studies suggest that collaborative learning enhances the knowledge-building discourse. Emerging literature suggests that students can learn and understand mathematical concepts in an enriched way when the subject is approached in a discursive, collaborative fashion.

In implementation to date, however, carefully designed online collaborative problem-solving exercises have been insufficiently supported by student participation. This study examined the experience of one particular CSCL program, Virtual Math Teams (VMT) Project , which uses a collaborative problem-solving approach to mathematics. The intention of this program is to get students to work together online to solve mathematics problems. The distinctive feature of this exercise is a collaborative effort by a group of students to solve a problem.

The problem investigated in this study was why students showed resistance to using the Virtual Math Teams (VMT) chat service tools, and what methods may be used to motivate students to engage in these collaborative problem-solving exercises. The goals of this study were to examine The Math Forum's program experience to determine why the collaborative exercise VMT Chat is beset by student refusal to register and participate, and why the number of registrants and participants in the individually oriented Problems of the Week (PoW) are substantially higher than those of the VMT Chat. This study helped determine what factors motivate students to register and participate in this program.

Four reasons for a lack of participation in the VMT Chat program were found: a lack of teacher encouragement, a lack of integration of the VMT Chat program in math classes, a potentially confusing and difficult to use computer environment for the VMT Chat program, and a lack of available information, advertising, and marketing for the program.

The study contributes to the knowledge of online learning and collaboration by the determination of why participants are resistant to registering and participating in the VMT Chat; and factors that help to motivate users to shift from acting as individually-oriented problem solving users to online problem solving collaborators.

Dedication

This dissertation report is dedicated to my beautiful daughter Alexis, my wonderful husband Kenneth, my parents, Jack and Annette and my sister Stacy.

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Chapter 1

Introduction

Statement of the Problem

Despite the rapid growth of online education in recent years, studies have revealed student resistance to computer-supported collaborative learning (CSCL) programs. The literature has reported cases where educators and designers have responded to the technical or social obstacles that have been cited as reasons for student failure to make effective use of CSCL in a new and improved, student-friendly CSCL environment (Astleitner, 2002; McLoughlin & Luca, 2002). According to Astleitner, even in these cases of instructor and curriculum improvement, the CSCL programs have still encountered some active student resistance to proper use of collaboration.

On the other hand, Astleitner, Brunken, and Leutner (2003) evaluated teaching software products by applying principles of good instruction and found that individual learning remains the core process and outcome in online education. Their findings suggested that, while the CSCL material was comprehensive and presented in a well-organized manner, it suffered from strong deficits with respect to active learning and motivational support. This evaluation assumed that the learner was self-regulated without help from a teacher, because self-regulated learning remains the dominant paradigm in recent educational media research and development (Astleitner et al.).

Most educators therefore feel that collaborative learning programs require further study and development. Mandl (2002) theorizes that successful attainment of learning and teaching goals with the new technology requires a better understanding of the forms of informal and implicit learning. Specific areas that require even more intense research include the role of student interest and motivation relating to collaborative learning.

The most surprising finding of these studies of implementation problems with CSCL is that students are resisting collaborating online, particularly in problem-solving exercises that would seem to lend themselves to outside support and demonstration. The reasons why this resistance has been encountered are by no means clear to researchers, however (Perreault, Waldman, & Zhao, 2002). If a substantial number of students avoid participating in these exercises as the coursework progresses, then the purpose of the problem as devised by educators is defeated, and the educational value embedded in the problem exercise as a result of its collaborative problem-solving nature is lost.

Student resistance to online learning may be due to a number of factors, including aversion to technology, reluctance to gain proficiency in courseware, lack of motivation, or to a sense of isolation in the absence of a traditional classroom. Some students seem to have personality traits creating a preference for learning in relative isolation (Hoadley, 2002; Kaptelinin, 1999). The success of collaborative learning in mathematics may not be math-related. Emerging literature suggests that mathematics as a subject is not refractory to a collaborative approach (Burris, Heubert, & Levin, 2004; Hubbard, 2000; Johanning, 2000). If the subject matter itself does not contribute to the problem of student resistance, then the focus of the investigation changes to approaches that mitigate other factors.

The Math Forum, an internet-based resource for online mathematics and mathematics educator assistance at Drexel University, is experiencing student refusal to register and participate in the Forum’s synchronous online collaborative problem solving exercise known as VMT Chat, while the number of registrants and participants in the asynchronous, individually oriented Problems of the Week (PoW) are substantially higher than those of the VMT Chat. This study examined the experience of The Math Forum's program.

The problem investigated in this study is why students exhibit resistance to using the VMT Chat, and what methods may be used to motivate students to engage in these collaborative problem-solving exercises.

Goals

The focus of this study was to determine why the collaborative exercise VMT Chat is troubled with student refusal to register and participate, and why the number of registrants and participants in the PoW are substantially higher than those of the VMT Chat. This study also determined what factors help motivate students to register and participate in this collaborative exercise. The primary focus of the study was on high school students, as the initial research on the VMT Chat has been conducted on students in grades 8-11.

In addition, this study determined what solutions can be put in place to motivate students from positions as individually oriented problem solvers to online problem solving collaborators. This study will provide insight to researchers, teachers, and subject matter experts as to what instruments can be utilized in an online collaborative environment that will provide collaborators and potential collaborators with reasons to participate in an online collaborative learning environment, as well as continue to enroll and contribute in an online collaborative environment.

The Math Forum aims to provide resources, activities, person-to-person interactions, educational services and products to support teaching and learning. The Geometry Forum was founded in 1992 at Swarthmore College and expanded to become The Math Forum in 1996. The forum's development was funded by the National Science Foundation, and it became part of the Drexel University curriculum in 2001, where it began operation within Drexel's School of Education in 2004. The Math Forum has integrated distance learning technology into formal education and is considered a very successful application of the internet to education (The Math Forum, 2005).

To use The Math Forum's Problems of the Week (PoW), students individually log on to a problem and seek to solve it on their own. PoW encourages students to learn the subject matter while trying to solve a problem using reasoning, experimentation and computational skills. This service posts math problems at various grade levels (7-12) in core math subjects (e.g., algebra, geometry, pre-calculus) for students to solve. The PoW service is a successful online mathematics environment which has established a track record in attracting students to use the service, and is now expanding its services in the form of an online collaborative learning environment.

The Virtual Math Teams (VMT) project, an NSF-funded research effort, applies digital library resources to collaborative mathematics learning. The aim is to develop an environment for K-12 students that nurtures meta-cognitive and reflective interactions, fosters a deep understanding of math, and uses peer interaction to improve math problem-solving and communications skills (Virtual Math Teams, 2005).

The VMT project addresses the following issues relating to the present study:

- How to group students for effective collaboration
- How to design math problems for collaborative solution
- How to structure the collaborative experience online
- How to study the forms of collaboration that take place

The initial research of the VMT project has concerned collaborative problem-solving situations. The Math Forum hosted online instant messaging chats that generally involved 8^{th}-11^{th} grade students solving geometry and algebra problems. The sessions were known as “VMT Chats” and were open to the public. The VMT Chat curriculum and concept was developed on the expectations created by the success of The Math Forum’s Problems of the Week (Virtual Math Teams, 2005).

Evaluation of the program is now under way, providing the first opportunity to assess VMT's effectiveness. Researchers are reviewing data including videos of face-to-face sessions and online chat logs to analyze the collaboration process and mathematical thinking. The results will be used to define elements of a software environment that will support improved collaborative problem-solving (Virtual Math Teams, 2005).

Relevance and Significance

Background of the Study

Computer and multimedia technologies are seen as useful tools for productive exchanges between students and teachers that have the potential to enhance the quality of education. Moreover, the multimedia world is changing the very notion of literacy itself, and some researchers theorize that the “current notions of literacy will be obsolete when today’s new readers and writers have finished primary school” (Kimber, Hitendra, & Richards, 2002, p. 155). One of the most promising developments in the field is computer-supported collaborative learning, the building blocks of which were in place a generation ago, and the use of which accelerated after the introduction of Lotus Notes in 1989 (Kay, 2004).

Problems CSCL has Experienced

The significance of this study lies in the fact that the literature has focused primarily on collaboration and its advantages, in the context of computer-support collaborative learning, and tended to overlook the problems that CSCL has experienced in implementation. In particular, numerous studies on CSCL programs have noted student resistance to the program and have provided anecdotal or conjectural frameworks for considering why students might have shied away from logging onto the CSCL program. However, few have empirically measured the extent of resistance or sought out specific reasons why students have resisted (Brandon & Hollingshead, 1999).

Recent studies have revealed continuing student resistance. The literature has reported cases where educators and designers have responded to every technical or social problem that has been cited for student failure to make effective use of CSCL, and thus produced a new and improved, and student-friendly CSCL environment (Astleitner, 2002). However, even in these cases, the programs have encountered outright and active student resistance to make use of them properly.

Some recent studies have reported outright student resistance to engaging in CSCL, both generally and specifically, in the area of mathematics. One study reported in detail how researchers constructed and designed a CSCL environment in mathematics using Lotus Notes for students to use, and bravely predicted improved learning outcomes as a result of student use (Halloran, Rogers, & Scaife, 2002). But to their surprise, these researchers found that, "despite Lotus Notes being apparently suited to students' and tutors' needs, the students avoided using it" (p. 1). While conceding that "resistance to the use of Lotus Notes for collaborative work is not a new finding" (Halloran et al., p. 1), researchers had to change the direction of their research, and focus on what were the issues that caused student resistance. They determined that design and interactivity issues and lack of student knowledge about how to use Lotus Notes were probably most responsible for student resistance (Halloran et al.).

Another mathematics program was designed to help high school math students collaborate with chemical engineers in a real world context, but 40% of the math students "accepted a zero on the assignment rather than collaborate with the chemical engineers"

(Guzdial et al., 2001, p. 25). These anecdotes “paint a stark picture of active resistance to collaboration” in mathematics (Guzdial et al., p. 25).

One study analyzed how focused participants in one group problem-solving discussion were, and whether they stayed on task or became preoccupied with other elements during a mathematical conversation (Sfard & Kieran, 2001). The authors of the study believed in the importance of conversation, basing their arguments on Vygotsky and Piaget studies that indicate the benefit of students verbalizing their mathematical thinking. The importance of mathematical communication, as opposed to simply silently working on problems, has been a major trend in math education in schools recently. A disturbing result of the study, according to Sfard and Kieran, indicated that the interaction between the two boys were unhelpful to either of them. Their communication was ineffective, and unfocused, and lacked effort. As a result, the expected synergy to be derived from collaboration, ended up as entropy. The results lead the researchers to the conclusion that the road to knowledge sharing can be difficult to achieve.

The literature also reflects findings from studies in which the students found collaborative group work in mathematics to be helpful. In a study of middle- and high-school students participating in a collaborative mathematics classroom environment, Edwards and Jones (2003) found that the range of students recognized the benefits of collaborative group work in mathematics. They felt confident, listened to, and successful. The student feedback also indicated that they learned the math faster in groups than they could have individually. Working with friends was clearly important as well, apparently for the respect they were willing to extend to each other. The responses of the younger students (age 12-13) had more difficulty describing perceptions of collaborative work and concentrated more on outcome. The older students demonstrated more understanding of the processes involved in collaboration and in the math problems.

The Connected Mathematics Project (CMP), funded by the National Science Foundation, is a math curriculum for grades 6-8. Students solve real-life problems in collaborative groups and develop strategies for solving different, related problems every day. The teacher's role is to guide the students toward discovery of the concepts. Students are expected to verbalize and explain their techniques. Cain (2002) evaluated the CMP for efficacy. She found that CMP schools significantly outperformed non-CMP schools. Students and teachers were given a questionnaire, and both groups thought that the program helped the students to become better problem solvers.

Roskowsi, Felder, and Bullard (2002) evaluated student resistance to instructional technology. Although students are not necessarily technophobes, they do not necessarily want to add to workloads by engaging in a learning curve to master new courseware. Different motivational strategies are needed for the three periods of the learning process. Learners are initially affected by the perceived need for material and their attitudes toward the material. During the process, they are motivated by the stimulation provided by the material and by the emotional content of their experience with it. At the end of the process, motivating factors include student competence with the learned material and the reinforcement gained by using the mastery of the material.

The extent to which shared understanding of knowledge can be realized is largely dependent on the effectiveness of interaction between students. The cognitive and social advantages of group learning are lost if the interaction is not effective (Soller, 2001).

Educational Value Lost

Educational value is being lost as a result of student resistance to CSCL. As a result, the research question is why, when CSCL environments have so much to offer, students continue to stay away from these sites and fail to use them. This theoretical question is of great practical importance, because a CSCL program cannot thrive or even survive if there is not a critical mass of users participating in their execution.

Challenges to Online Learning Environments

Although lauded by educators and researchers, the "integration of flexible online learning into…education presents great challenges for all institutions" (Putz & Arnold, 2001, p. 182). While educators confidently promote online learning, and student computer skills certainly seem equal to the task (Thomas, 2002), the education field continues to offer formal computer training to less than half of students, and only one third allow students to access homework or review report cards online (Thomas). Only 43% of all teachers have sufficient skills to make use of CSCL, and the internet is made "very little use of" (Thomas, p. 1) by most teachers. All in all, there remains a wide gap between theory and practice in the use of computer-supported collaborative learning in school.

Moreover, while a great deal of the literature on CSCL reports that collaborative learning can be effective in generating positive academic outcomes, most of these outcomes are limited to elementary and secondary school, and all are based on studies undertaken in traditional classroom contexts. Though there is growing evidence that collaboration improves upon individualistic education in terms of helping students think better and improve their “generation of ideas and solutions” (Brandon & Hollingshead, 1999, p. 110), once again, most of these studies of collaborative learning theory have “dealt primarily with standard, classroom-based groups, not electronic groups” (Brandon & Hollingshead, p. 10). This shortcoming naturally “raises the question of how well the benefits of collaborative learning will translate to the electronic environment” (Brandon & Hollingshead, p. 10). Talavera and Gaudioso, of Barcelona’s Technical University of Catalonia, observe that within the online learning community itself, CSCL is but one approach, offering a “context-aware interface intended to structure the interaction” (Talavera & Gaudioso, 2004, p. 1). Whether or not it can withstand competition from unstructured collaboration through open interfaces designed to communicate and share knowledge remains an issue (Talavera & Gaudioso).

The gap between theory and practice in CSCL has troubled some researchers, particularly because so much of the literature on CSCL claims that collaborative learning “can be effective in generating positive academic and affective outcomes” (Brandon & Hollingshead, 1999, p. 110). Collaboration, defined by researchers as “a coordinated, synchronous activity that is a result of a continued attempt to construct and maintain a shared conception of a program” (Brandon & Hollingshead, p. 111), has in fact become a fashionable buzzword in constructivist educational circles, as a result of these studies claiming a positive impact on learning. In CSCL, then, traditional classroom learning is not simply transferred to an online environment; on the contrary, it is claimed that a new type of learning occurs, as students "learning through actively participating in knowledge building as a member of a group" (Brandon & Hollingshead, p. 111).

In addition to providing positive achievement and test score outcomes, CSCL has been shown to alter the very nature of student learning as a mutual effort. Kaptelinin (1999) points to "compelling evidence that situations of joint problem-solving are often associated with more efficient use of higher-level skills and knowledge, including reflection, planning and meta-cognition" (p. 501).

Roschelle, Pea, Hoadley, Gordin, and Means (2000) note that advances in cognitive research show learning to be most effective in the presence of four basic characteristics: (1) active engagement, (2) participation in groups, (3) frequent interaction and feedback, and (4) connections to real-world contexts. Some of these learning researchers have explored how technologies can improve learning. The structure and resources of the traditional classroom setting do not always support learning effectively, but technology, applied effectively, can be used in ways much more congruent with how children learn (Roschelle et al.). The technology that allows communication in cyberspace can be an excellent medium for fostering new social relationships within or across classrooms. These relationships result in collaborative, meaningful, and cross-cultural human interactions that foster the learning process (Liu, Moore, Graham, & Lee, 2002).

As the CSCL literature matures, more researchers are refining theory about the function and benefits of collaborative learning and thus drawing a distinction between cooperative and collaborative learning. In the former, group members divide up tasks in a project, and then return from subtasks to contribute to a final outcome. In collaborative learning, students look at whole problems and seek to share understanding and ideas.

Prince (2004) defines the core elements of collaborative learning as working collaboratively rather than individually, for example, when a small group of students work toward a common goal. In cooperative learning, cooperation is used rather than competition, but individual assessment is retained.

Collaborative group activity proceeds with an assigned task from the instructor to a small group, which works to produce an outcome to the task, and present the outcome to the instructor. Cooperative learning techniques are seen as more structured learning tasks in that they are monitored closely by the instructor (Summers, Beretvas, Svinicki, & Gorin, 2005).

Edwards and Jones (2003) draw this distinction:

> Co-operative group work is primarily task-orientated with roles and goals assigned at the outset, often by someone outside the group such as the teacher. In contrast, *collaborative* group work involves students working jointly on the same problem at all times. Within a collaborative group, decisions are shared and the negotiation of roles and relationships constantly evolves (p.135).

The CSCL discourse has also received infusion from those educators seeking ways to create learning communities, or virtual communities online, where “groups of people with common interests and goals use the Internet resource to improve their communication and coordination” (Talavera & Gaudioso, 2001, p. 1). This infusion has created the impetus for CSCL to push itself further, so that CSCL entails not only a technical but also a dramatic pedagogical change.

There has been “a reasonable amount of published experiments showing positive learning effects when CSCL systems have been applied in classroom learning” (Lehtinen, Hakkarainen, & Muukkonen, 1998, p. 36). Studies are less conclusive on the value of CSCL online, however (Guzdial, 2003). Nonetheless, select studies have shown that CSCL improves student test scores (Guzdial), helps students exchange ideas more productively (Vizcaino & Du Boulay, 2002), and can help students achieve a group purpose, which is believed to improve student skills (Crawley, 2004). All of these findings resonate among educational theorists, leading many to argue that improvements derived from CSCL closely relate to the “recent development of theories of learning and instruction” (Lehtinen et al., p. 35) such as constructivism.

It is all the more inexplicable to educators, then, that CSCL has begun to encounter problems in terms of implementation. The most surprising result of several studies of implementation problems with CSCL is that students are resisting collaborating online. The reasons why this resistance has been encountered are by no means clear to researchers. Some argue that current implementation of CSCL has insufficiently broken away from the traditional classroom model, and thus is not properly exploiting the advantages of online learning (Perreault et al., 2002, p. 314). Many teachers are simply dumping lecture notes onto the web, without giving due consideration of how “teaching materials designed for a different delivery medium” will not be effective there (Ngor, 2001, p. 53). Document sharing by way of e-mail is also “a long way from collaboration”

(Kay, 2004, p. 42). Moreover, if teachers move online, but retain a teacher-centric sense of their role, the responsibilities of managing a CSCL environment will overwhelm them (Astleitner, 2002). On the student side, researchers are acknowledging that developing true collaborative learning relationships in school is difficult (Walther-Thomas, Korinek, & McLaughlin, 1999, p. 1).

The success of students' online collaborative efforts depends somewhat on individual personality traits. Students who are more socially outgoing, agreeable, and amenable to intellectual or imaginative experiences (high-profile) seem to be able to more effectively meet collaborative goals. On the other hand, socially retiring, reserved students (low-profile) who are not equipped for or interested in sustained social interaction are less likely to engage in collaborative learning online. Mixed groupings of these students increased the effectiveness of collaboration (Chen & Caropreso, 2004).

While implementation problems continue to plague CSCL and educators offer technical solutions, a more specific problem has been cited in cases where all of the technical barriers cited have been removed from CSCL, and yet the programs have encountered outright resistance by students (Halloran et al., 2002). It has greatly surprised researchers that students have avoided using such programs as Lotus Notes, and shown "active resistance" to other collaborative program tools (Guzdial et al., 2001, p. 25). Looking at these instances, "multiple interacting factors" have been blamed for such resistance (Halloran et al., p. 1). It remains that much more needs to be known about why this resistance is occurring, and for what reasons.

If an online CSCL service or a collaborative exercise per se, does not achieve a sufficient critical mass of usage by students, then the entire mission of the program and the purpose of offering CSCL in a course are undermined. It is therefore important that CSCL designers come to a better understanding of why students are actively resisting using CSCL. Whether the reasons are technical, social or motivational, a gaining a better understanding of student resistance to CSCL is crucial in order to overcome the roadblock which currently plagues CSCL implementation.

Barriers and Issues

The literature has suggested that, as traditionally taught, math education continues to tend to be individualistic in orientation, encouraging solitary or competitive problem-solving expertise. Even in classrooms, educators have encountered resistance to the constructivist program to replace the individualistic-competitive orientation in mathematics learning with a group-collaborative problem-solving environment. If the subject matter—mathematics itself—is the barrier to student participation in a collaborative environment, how can a shift be implemented to the new kind of learning collaboration is thought to offer?

Distance education (DE) has focused more on the use of technology and less on collaborative and teamwork approaches, so that strategies that address the creation of "communities of learners" are neglected. Technology is emphasized because both instructors and students are captured by the novelty. While technology is a valuable tool, choosing courses should take into consideration the quality of the content rather than the available technology (Dahl, 2004).

Research has been more focused on the mechanics of using the Internet rather than the effective application of that technology to attaining educational objectives. “The integration of flexible online learning into education presents great challenge for all institutions” (Putz & Arnold, 2001, p. 182). However, guidelines are catching up to the technology. The Southern Regional Education Board (SREB) operates the "Electronic Campus," which offers an electronic marketplace for programs and courses offered by accredited universities and colleges. SREB requires its members to meet its principals of good practice. These practices address the rigor of learning outcomes, the provision of appropriate real-time or delayed interaction between students and instructors, and programs that are comparable to those delivered by other means. Students are provided with clear, complete, timely information on curriculum, course and degree requirements, and the resources needed for the course are provided. There is provision for assessments of student learning and outcomes (Electronic Campus Best Practices, 2004).

The characteristics of online communities are becoming more clearly delineated as the field evolves. An awareness of structuring online communities, the need to practice working with the technology, and assessment of online learning and participation are factors that are commonly considered in program design (Charalambos, Michalinos, & Chamberlain, 2004). Additionally, design centers on the cornerstones of collaboration, communication, participation and interaction. Communities are coming to be viewed as extending beyond one course to a broader curriculum and globally within professional organizations. Data emerging from years of developing programs is enabling researchers to conduct action research and shape design elements (Lock, 2002).

Research Questions

The following questions have guided this research:

1. Why, when an acceptable number of students are using The Math Forum's online CSCL component PoW, have students failed to participate in and shown active resistance to the new VMT Chat program offered by The Math Forum? Documents such as PoW problems, statistics on student attendance and repeats, interviews with students and questionnaires were used for the purpose of providing insight in recognizing the reasons why students were failing to participate in VMT Chat and why they were actively resisting the VMT Chat service.
2. What will motivate individual problem solvers who currently participate in PoW to register and participate in VMT Chat and become collaborative problem solvers? Documents such as statistics on student attendance and repeats, interviews with students and questionnaires were used for the purpose of providing insight in recognizing methods of introducing the VMT Chat service to current PoW participants and motivating registration and participation.
3. When the motivators are implemented, will they result in increased participation by the students? Statistics on student attendance and repeats,

interviews with students and questionnaires were used for the purpose of determining whether there was an increase in student participation in VMT Chat, and what motivators were responsible for the increased use of the VMT Chat service.

Limitations and Delimitations of the Study

Limitations

Gay (1996) states that a limitation is an aspect of a study that the researcher knows may negatively affect the results, or generalizability of the results, but over which he or she probably has no control. The limitations of this study were derived from the particular characteristics of the case study program, The Math Forum, which may or may not disqualify the results of the study from broad generalizability. The Math Forum has already developed a following of individual-oriented users who log on regularly to solve a Problem of the Week (PoW). In that sense, then, the VMT Chat is pre-sold, and has a built-in audience. This also means that the VMT Chat program did not have to work to distinguish itself in the online world, as it came to fruition with brand name recognition. This may or may not impact the reasons why students who use PoW subsequently chose not to use VMT Chat.

Moreover, the fact that The Math Forum is a mathematics-based computer-supported collaborative learning environment may itself limit the generalizability of the study. The literature has suggested that, as traditionally taught, math education continues to tend to be individualistic in orientation, encouraging solitary or competitive problem-solving expertise (Sfard & Kieran, 2001). Even in classrooms, educators have encountered resistance to the constructivist program to replace an individualistic-competitive orientation in mathematics learning with a group-collaborative problem-solving environment (Sfard & Kieran). To what extent this pre-existing problem carries over into the results of this study may limit the applicability of the findings to other fields. Whether or not there can be collaboration in math, let alone in a math CSCL, remains an open question. The open-endedness of this question as it currently stands in the literature may present a barrier to coming to any clear conclusion in this study as well. If the subject matter—mathematics itself—is the barrier to student participation in a collaborative environment that in turn presents researchers with a formidable challenge, how does one change the entire educational culture of a subject area, in order to get students in that field to collaborate with each other online? It is acknowledged that the mathematics-centered nature of the findings greatly limits the generalizability of the results.

Delimitations

Anything that the researcher does to or with the population sample that might affect the generalizability of the results is a delimitation. This research concentrates on the study of The Math Forum’s VMT Chat service whose current participants have both full e-mail and Internet access. This research focused primarily on high school students in grades 8 through 11.

Definitions of Terms

Alternative instructional paradigm: A generalized name for any educational environment where, according to the mandates of constructivist theories of education, students learn by doing, in problem-solving activities. In the case of CSCL, which is increasingly being seen as an alternative instructional paradigm, this problem-solving is shared over distributed learning environments (Dede, 1999).

Computer-supported collaborative learning (CSCL): Any online environment in which students are required to log on and communicate and collaborate with each other in studying or solving a problem.

Critical thinking: Increasingly desired as the goal of optimum CSCL programming, critical thinking is defined as a higher-order thinking skill which entails evaluating arguments, and results in interpretation, analysis, evaluation and inference (Astleitner, 2002).

Groupware: Applications in a collaborative software that allows online students to work together on a problem in simultaneous real-time. A special problem that CSCL designers face is that most groupware programs are designed to work best when a "high percentage of group members use it" (Lehtinen, et. al., 1998, p. 7).

Lotus Notes: An early example, with development beginning in 1984 and released in 1989, of online service which provides tools which allow users to transform textual documents into databases "without the usual constraints of field and record length associated with normal databases" (Lehtinen et. al., 1998, p. 6).

Lurker: A special target of CSCL researchers, a lurker is a student who is “awake and listening (in class) but does not become actively involved unless forced to do so” (Dede, 1999, p. 3). When lurkers are forced to participate, they do so, but then “relapse into silent observation” (Dede, p. 3). Because, it has been argued, these students must be rejecting face-to-face communication, it has been the hope of CSCL designers that they will awaken the lurker online, thus improving student learning.

Positive interdependence: A quality which CSCL designers seek as a necessary prerequisite of effective collaborative learning. Positive interdependence means that the students not only work together, but they do so because they have developed a common learning goal, and thus participate together in all phases of the research project (Brandon & Hollingshead, 1999).

Social cohesion theory: An important theoretical support for the development of collaborative learning environments, this theory argues that students who come to identify with groups will perform better in school, and that, indeed, the source of the student’s motivation to learn is his or her identification with a group, “assuming that a sufficient group identity is formed by group members” (Brandon & Hollingshead, 1999, p. 113).

Teamware: A communal database which serves as a central platform for discussion and interaction, allowing students access to a variety of mail protocols, as well as an electronic bulletin board, a library, a document management system and storage (Lehtinen et. al., 1998).

Virtual online communities: Online communities where "groups of people with common interests and goals use the Internet resource to improve their communication and coordination" (Talavera & Gaudioso, 2004, p. 1).

Summary

A significant problem facing collaborative online learning sessions is that most of these environments are built around groupware programs that are designed to work best when a "high percentage of group members use it" (Lehtinen et. al., 1998, p. 7). If an insufficient number of students participate, then the purpose of the problem as devised by educators is defeated, and the educational value embedded in the problem exercise as a result of its collaborative problem-solving nature is lost. As a result, it is essential that these groupware-based environments achieve a critical mass of users, in order to operate at a level which will bring out the educational advantages of CSCL. For all of the theoretical discussion of the need for individual users to collaborative online, and how beneficial collaboration is to these students educationally, if a CSCL site attracts only one or two students then the advantages of the environment as designed are severely compromised (Lehtinen et. al., 1998, p. 7). Moreover, if a site takes too long to attract a critical mass of users, then it may never obtain a steady flow of users, as the original adapters may abandon the site before the late adopters take to it. In several ways, if a CSCL environment does not gain a sufficient number of users, then the theoretical advantages of CSCL are moot.

The failure of students to enter upon collaborative problem-solving exercise with other students online must be considered ironic, as available groupware offers productive collaborative tools (Fichter, 2005). The fact that sites such as the VMT Chat problem-solving exercise on The Math Forum is failing to attract student users, and, indeed, meeting with active resistance by these students to make use of the site, has caused considerable consternation and questioning among researchers. Educators and researchers, reviewing cases where students did or did not choose to participate voluntarily in a site, have devised a number of theories as to why students are staying away. These reasons have to do with a range of issues, across a spectrum of technical, social and educational issues. Perhaps students, lacking the cues offered to collaboration in face-to-face communication, simply do not know how to collaborate online, or do not like, or even think of collaboration online as effective collaboration. Perhaps the technology presents students using groupware with far too many barriers, all of which accumulate to hinder and inhibit effective communication. Or, perhaps, though constructivist learning theory touts collaboration as a powerful impetus to improved achievement, students do not want to learn collaboratively. If the culture of a traditional discipline is particularly individualistic, as in the case of mathematics, then it may be that students do not even conceive of the possibility of collaborating, where they have always seen mathematics problem-solving as a competitive activity undertaken between two or more individuals racing to achieve an answer first.

This study looked at the performance of VMT Chat, a new feature of The Math Forum, where students are encouraged to log on and participate, in a groupware context, in a collaborative problem-solving activity. Participation in this activity is believed by the designers of VMT Chat, and by educators, to potentially offer these students a richer learning experience that will improve their achievement levels in mathematics. VMT Chat was developed on the expectations created by the success of The Math Forum's Problem of the Week element, in which students individually log on to a problem and seek to solve it on their own. Experience thus far has indicated that few students seem willing to participate in the collaborative VMT Chat learning effort. This study examined an implementation of VMT Chat and then studied the response of students to the program. Through questionnaire and data collection this study determined why these students have resisted using the program. On the basis of this study, recommendations are made as to how The Math Forum's VMT Chat can be improved, made more inviting, and the barriers to student use be lowered, so that the site can attract a critical mass of students to its problem-solving activities. This study, focused on a particular CSCL program, shed light on the conundrum of student resistance to CSCL, thereby helping to overcome obstacles to implementation.

Chapter 2

Review of the Literature

Introduction and Historical Overview

Computer-supported collaborative learning (CSCL) has grown exponentially in recent years, much of the growth being fueled by researcher promotion and early positive results of its implementation on student achievement and the quality of learning occurring in schools in general (Brandon & Hollingshead, 1999; Choi & Ho, 2002; Crawley, 2004; Day, Lou, & Van Slyke, 2004; Graves & Klawe, 1998; Lehtinen et al., 1998). In spite of a preponderance of evidence indicating that CSCL can improve learning in various ways, the literature remains aware of the difficulties of instituting CSCL, and, more challenging, making it work, or deriving expected theoretical results in practice. Whether or not collaboration improves learning or not remains an issue of debate. How to improve collaboration, what constitutes true collaboration, and how collaboration improves education also remain topics of discussion. Student resistance to collaboration and especially collaboration in online or CSCL situations has recently become a barrier to the development of CSCL. In many cases, researchers and educators have mapped out the theory and implemented a CSCL learning module that they believed would help students, and the students have subsequently balked at using the system. Why students are resisting the use of CSCL therefore has increasingly become a topic of study. Specific programs, from elementary to the collegiate level, have been examined, to determine why students have failed to use the programs. As a result of these investigations, researchers have pinpointed barriers to CSCL which must be overcome, and problems in its implementation which must be solved, in order to smooth the path of student adoption of the technology and the benefits of educational collaboration.

The development of Computer-supported collaborative learning as a specific field in online educational studies has naturally evolved from commonsense beliefs about the value of media in assisting and improving education. Along these lines, it is argued that if a medium is simply a container for new kinds of messages, then the use of new media in education would "broaden the types of instructional messages students and teachers can exchange" (Dede, 1999, p. 1). More media means more education. Moreover, the traditional educational world of books is being consumed by the multimedia world in which all students now live, and education must adjust (Kimber, Hitendra, & Richards, 2002). Multimedia has become "the dominant communication channel in all sectors of the community and the indisputable fact (is that) current notions of literacy will be obsolete when today's new readers and writers have finished primary school" (Kimber et al., p. 155). While the literature repeatedly preaches the message of the need for students today to have multiple literacies, less is said about changing pedagogical paradigms (Kimber et al., p. 155).

Indeed, the integration of computer-supported collaborative learning into education has been slow. The building blocks for collaborative online learning were in place a generation ago, when Doug Engelbart devised the elements "used in virtually all modern collaboration software," including data structures (hypertext), user interfaces (windowing systems) and applications (groupware)" (Kay, 2004, p. 45). Nothing happened in collaboration, however, until Lotus Notes was introduced in 1989. But the deployment of Lotus Notes itself was slow, and it took some time before Microsoft and others entered the market (Kay). Only in the mid-1990s was there renewed interest in the development of collaborative software, with numerous companies entering the field. Finally, it is only in the past five years that educational leaders have begun to see the potential benefits of CSCL for education.

Nonetheless, “the integration of flexible online learning into education presents great challenge for all institutions” (Putz & Arnold, 2001, p. 182). For one thing, while the technology is available, “explicit educational guidelines for implementing online seminars are still rare” (Putz & Arnold, p. 182). School leaders report a “surprising confidence” in online learning, with one third of all leaders surveyed in one study believing that online learning will become significant in years to come, and they “expect one out of five students (will receive) a substantial portion of instruction online” (Thomas, 2002, p. 1). This expectation seems borne out by student computer skills. More than half of the nation’s school districts report that “kids are the campus experts when it comes to school technology” (Thomas, p. 1). 55% of schools say students provide technical support, 42% say students troubleshoot for hardware, software and infrastructure problems, and “in 39% of schools students set up equipment and wire schools” (Thomas, p. 1).

At present, however, less than half of all schools provide students with formal computer training, and while 90% of schools now communicate news to parents via the Web, only 33% let students access homework or review report cards over the web

(Thomas, 2002). Moreover, only 43% of teachers claim that their ability to use CSCL is above average (Thomas). Currently, CSCL is mostly used in history (75%), science (58%), and most "internet use in today's classrooms is for research-based projects, with very little use of the internet's unique brand of interactive teaching and learning and collaboration" (Thomas, p. 1). Worse, "most teachers simply (do) not bring their classes to the media center" (should a school have one)" (Bacon, 2004, p. 28). All in all, there remains a wide gap between theory and practice in the use of computer-supported collaborative learning in school.

The literature on CSCL in particular also reveals some growing pains. While it has been theoretically mapped out that CSCL software involves three types of tools — electronic communication tools, electronic conferencing tools, and electronic meeting systems— education has only made significant progress in the first area. While many teachers and students now use electronic communication tools such as email and instant messaging, fewer create tele- or videoconferences, and only in distance learning situations are classrooms set up with PCs and screens in order to facilitate electronic meetings (Kay, 2004).

While a great deal of the literature on CSCL reports that collaborative learning "can be effective in generating positive academic and affective outcomes" (Brandon & Hollingshead, 1999, p. 110), most of these outcomes are limited to elementary and secondary schools, and all are based on studies undertaken in traditional classroom contexts. Though there is growing evidence that collaboration improves upon individualistic education in terms of helping students think better and improve their "generation of ideas and solutions" (Brandon & Hollingshead, p. 110), most of these studies of collaborative learning theory have "dealt primarily with standard, classroom-based groups, not electronic groups" (Brandon & Hollingshead, p. 10). This shortcoming naturally "raises the question of how well the benefits of collaborative learning will translate to the electronic environment" (Brandon & Hollingshead, p. 10). Distance learning has assisted CSCL in indicating how to personalize online learning, but as yet "definite results" showing that the use of the internet improves education have not yet been derived (Chomienne, Potvin, d'Halluin, & Vanhille, 1997, p. 2). Finally, within the online learning community itself, CSCL is but one approach, offering a "context-aware interface intended to structure the interaction" (Talvera & Gaudioso, 2004, p. 1), and whether or not it can withstand competition from unstructured collaboration through open interfaces designed to communicate and share knowledge remains an issue (Talvera & Gaudioso).

As the CSCL literature matures, more researchers are refining theory and thus drawing a distinction between cooperative and collaborative learning. In the former, group members divide tasks in a project, and then return from subtasks to contribute to a final outcome. Many educators do not believe that such cooperation in fact constitutes true collaboration, where a group of students work together on all parts of the project and produce a single, shared product (Brandon & Hollingshead, 1999). Collaboration has only recently come to be defined as "a coordinated, synchronous activity that is a result of a continued attempt to construct and maintain a shared conception of a program"

(Brandon & Hollingshead, p. 111). This newer, stricter definition of collaboration has placed even more pressure on CSCL design and implementation.

The CSCL discourse has also received input from those educators seeking ways to create learning communities, or virtual communities online, where “groups of people with common interests and goals use the Internet resource to improve their communication and coordination” (Talvera & Gaudioso, 2004, p. 1). This infusion has created the impetus for CSCL to push itself further, so that CSCL entails not only a technical but also a dramatic pedagogical change. CSCL must supersede traditional classroom practice—teacher-centered delivery of facts which must then be memorized—with a context where knowledge is created through social interaction and “students learn through actively participating in knowledge building as a member of group” (Brandon & Hollingshead, 1999, p. 111). As such, CSCL is increasingly being placed on the footing of an “alternative instructional paradigm” (Dede, 1999, p. 1), where students learn by doing, that is, by problem-solving activities shared over distributed learning environments.

The acknowledgement that CSCL entails a different kind of learning has also shown up the shortcomings of research in CSCL thus far. At present, most empirical studies of CSCL have entailed either in-depth studies of local activities, or a “bird’s eye view of computer use in a large educational setting” (Kaptelinin, 1999, p. 506). Neither type of study is sufficiently grounded in the awareness that “learning and development takes place at several levels simultaneously” (Kaptelinin, p. 506). That is, “research on collaborative learning should ideally focus on both specific details of how students interact with each other, with teachers and with technology, and the structure and developmental transformations of larger social settings" (Kaptelinin, p. 506). This approach has also allowed the literature to confront the problem of student resistance to collaboration.

Computer-Supported Collaborative Learning: Advantages

In order to properly comprehend the advantages offered by CSCL environments, it is necessary to review what they actually do. Examples of CSCL environments abound in the literature (Cononan & Pinkard, 2000; Lehtinen et al., 1998).

Belvedere is a CSCL environment created at the University of Pittsburgh which assists student cognitive activity in science. Belvedere helps students by providing them with a graphical language that expresses the steps of thinking —hypothesizing, data gathering and weighing of information —that they must follow. It also suggests next possible steps in studies, and structures materials and activities. Belvedere "also support(s) collaborative learning through the shareability of diagrams by students in same time same place, as well as through text-based chat windows" (Lehtinen et al., 1998, p. 29). Though as yet no studies have compared a Belvedere environment with traditional classrooms, case studies of experimental classes with Belvedere have shown that "students were engaged and on-task during the collaborative problem-solving situations presented them by the Belvedere comprehensive approach" (Lehtinen et al., p. 31).

Other CSCL environments created for use primarily in science include Computer Supported Intentional Learning Environments (CSILE) and Knowledge Integration

Environment (KIE), both of which “promote deep concept understanding and develop scientific inquiry skills by providing procedural and cognitive scaffolding” (Conanan & Pinkard, 2000, p. 1). Scaffolding, a form of guidance that uses prompts to help students “carry out tasks that might ordinarily be too difficult for them” (Conanan & Pinkard, p. 1), is at the core of both systems. A commercial version of CSILE, Knowledge Forum, issued in 1997, has added graphical functionality to the CSILE core. One study of CSILE interactions indicates that the “CSILE students shared their explanatory theories socially” a process which deepened their inquiries (Lehtinen et al., 1998, p. 29). CSILE includes a communal database, which allows one to search for and classify knowledge, as well as tools for text and chart processing.

Overall, these tools allow teachers to convert a classroom into something that looks more like a scientific community, with burgeoning scientists participating in science. Studies have found that CSILE does facilitate higher-order thinking, and collaborative knowledge building. In one study of elementary classrooms it was found that CSILE classrooms showed significant advantages over non-CSILE classrooms (Lehtinen et al., 1998). Another study focusing on 21 sixth grade female students in Canadian public schools found that the Knowledge Forum CSILE software enhancedmath "model-eliciting problem solving" through the collective discourse of the subjects regarding a basic rank-ordering problem (Nason & Woodruff, 2003).

KIE is more explicit still in transforming student inquiries into a process that looks like real science. The system provides students with procedural prompts and hints in a process of scaffolding that “helps students conceptualize scientific investigation in the way that experts do" (Conanan & Pinkard, 2000, p. 2). An important element of KIE is the Progress Portfolio, which provides the student with workspace wherein he or she can document, manage and communicate about their progress in the investigation (Conanan & Pinkard).

The general name for all information technology programs that allow students to work together, by providing them higher levels of coordination and cooperation, is groupware. As a concept groupware emerged in 1978, and was designed to add to the functionality of an individual when working in a group. At the core of most of the groupware programs developed, including Lotus Notes, Teamware and Team Focus, is a communal database which serves as a central platform for discussion and interaction (Lehtinen et al., 1998). Teamware includes access to a variety of mail protocols, as well as an electronic bulletin board, a library, a document management system, and storage. But it remains the communal database which has received the most praise from the literature, as the existence of this knowledge base "encourages organizations towards a more open sharing of ideas" (Lehtinen et al., p. 6). One can actually graphically configure the topics under discussion, in support of the discussion, and also "represent the knowledge elements currently under discussion and the relations between them" (De Vries, Lund & Baker, 2002, p. 69). The Envisioning Machine, another program, "offers a direct-manipulation graphic simulation of the concepts" under discussion, allowing students to analyze topics under discussion, and thus converge upon a new understanding of them (De Vries et al., p. 69).

Like most CSCL tools, the DDES Corps Classroom Network Teaching Tools is designed for use in classrooms from kindergarten through 12^{th} grade. It allows teachers to "transmit their screen to students' screens, view any student screen without their knowledge, remotely control student computers, monitor internet connections, and develop and administer online exams" (Robinson, 1998, p. 1). In Discourse GroupWare Classrooms instructors can monitor student responses and give private tutoring and feedback online. CONNECT is a CSCL environment created specifically to "create conditions for epistemic dialogue" and was programmed with HyperCard and Timbuktu to be used as a distance technology as well (De Vries et al., 2002, p. 71). Finally, Lotus Notes "lets users transform textual documents into databases…without the constraints of field and record length associated with normal databases" (Lehtinen et al., 1998, p. 6).

In the field of design, Studio Zone consists of a website that allows students to present digital images of designs to participants in a collaboration, all of whom can comment asynchronously on them (Conanan & Pinkard, 2000). The intention of this CSCL system is to foster student reflection and "enhance opportunities for students to support and learn from each other" (Conanan & Pinkard, p. 1). SMILE, a CSCL created at the Georgia Institute of Technology, also provides a "suite of technology tools to support collaboration and reflection during problem-based learning" (Conanan & Pinkard, p. 2).

Many researchers believe that "internet-based computer-mediated communication technologies are shaping the future of education" (Brandon & Hollingshead, 1999, p. 109). Even small changes in the way teachers and students use technology can have “pervasive impact on behavior and practice” (Hoadley, 2002, p. 7). Moreover, once a technology is introduced, the way it is used will also change over time. To date there have been a “reasonable amount of published experiments showing positive learning effects when CSCL systems have been applied in classroom learning” (Lehtinen et al., 1998, p. 36), but less conclusive studies on CSCL per se, in an online environment. In addition to providing positive achievement outcomes, CSCL has been shown to alter the nature of student learning, promoting the development of “higher order cognitive processes” such as critical thinking, skills which are deemed by many to be crucial for future work opportunities for alls students (Lehtinen et al., p. 36). Other studies are less conclusive about how CSCL can alter and improve student learning (Guzdial, 2003).

The advantages of CSCL have been noted in the literature. In early studies, CSCL was shown to have improved the test scores of participating students (Guzdial, 2003). In later studies, the focus has shifted, showing how student learning has been improved by CSCL. Some notable studies of CSCL include Roschelle’s study of learning physics collaboratively, and Jeong and Choi’s study of learning anatomy in a peer-learning setting (Guzdial). One study noted that online CSCL allow students to “exchange ideas and reflect upon points of view” more often than traditional classroom learning (Vizcaino & du Boulay, 2002, p. 1). Another study found that while instituting collaboration can be challenging in the classroom context, CSCL can streamline some of the problems of face-to-face collaboration (Guzdial). While it is difficult in class to form and maintain groups, and arranging meeting times and getting students to attend classes so that group meetings are not derailed even more so, the asynchronous nature of CSCL remedies these logistical problems (Guzdial). Because CSCL, as opposed to classroom learning, allows students to participate in a manner in accordance to their learning style and needs, CSCL has also been shown to enhance the very nature of their learning. With CSCL students not only exchange information or solve problems together, but are able to transcend social-related barriers to learning and thus interact as equals, develop shared mental models, shared purposes and common practices and thus form “bonds that fulfill some sound educational principles” (Crawley, 2004, p. 4). Group purpose is also believed to encourage students to improve their skills.

Studies of the effect of CSCL on student learning have thus far focused on small groups in computer-based instruction, and have indicated “at least some positive impact on student learning” (Lehtinen et al., 1998, p. 24). In a study comparing pairs of students to individual students participating in a problem-solving exercise, it was found that the students in pairs did better (Lehtinen et al.). Other studies have focused on the social aspect of CSCL, and found that it does indeed improve the “amount and quality of social interaction” in learning (Lehtinen et al., p. 23).

These findings all resonate among educational theorists, leading many to argue that the improvements derived from CSCL closely relate to “the recent development of theories of learning and instruction” (Lehtinen et al., 1998, p. 35). Constructivist educational theory argues that students learn better when they engage with other students in problem-solving exercises demanding the active use of critical thinking toward the creation of new knowledge. It is clear that computers can help to improve the social interaction among students, by leveling the unevenness of the playing field caused by personality and social issues (Lehtinen et al.). By providing students with groupware, with its network connections, interfaces and joint databases, “the facilitation of high quality social interaction is naturally more obvious” (Lehtinen et al., p. 35). With groupware also helping students to coordinate their interaction, it has been shown that groupware “creates interaction processes in which students are consciously constructing new knowledge on an inter-subjective or social level” (Lehtinen et al., p. 35). If CSCL be combined with CAL, which allows students to move at their own pace, it is argued that learning can be enhanced even further (Graves & Klawe, 1998).

Even the former distinction between the fields of CSCW and CSCL appears to be dovetailing under pressure of constructivist theory. According to this theory, it is also important that all learning be real-world oriented, and that students have a sense of the active and purposeful nature of their learning. Thus, the emphasis of CSCW on concrete products, once distinguished from CSCL’s interest in pure learning, is bringing the two fields together. Nonetheless, CSCW still places an emphasis on reducing cost, while CSCL seeks only to improve learning, that is, “CSCW aims at reducing mental effort, CSCL aims at increasing mental effort” (Crawley, 2004, p. 2)—and in this CSCL continues to demand more and higher levels of thinking from students.

The emergence of CSCL as a field has been supported by numerous educational findings, and theories, which indicate that collaboration per se improves learning (Brandon & Hollingshead, 1999). In classrooms, collaboration has been found to have “powerful effects on numerous cognitive and affective outcomes” (Brandon & Hollingshead, p. 122). Other studies have also found that collaboration can improve student retention, as individual students, if they are part of a group that depends on them, appear to become more responsible about attending class and keeping up with others (Guzdial, 2003). Once collaboration was introduced into classrooms, teaching methods and pedagogical theory began to shift away from teacher-centered delivery to student-centered construction of knowledge (Resta, Christal, Ferneding & Puthoff, 1999). CSILE has been used to provide students a workplace where they can collaborate on problem-solving efforts (Resta et al.). CSILE has been found to encourage building knowledge by "embracing all steps of the knowledge construction process, including questioning, guessing, predicting, planning, theorizing and discovery" (Resta et al., p. 491). CSILE also changes the way questions are asked in classrooms, as teachers give way to the numerous questions that derive from what is on students' minds, and what they are thinking about (Resta et al.). Once learning becomes embedded in a collaborative process, the former distinction between curricular content and the act of instruction vanishes, and rather "knowledge is constructed in the context of pursuing higher learning goals" (Resta et al., p. 492).

The use of CSCL in classrooms and online thus pushes learning in the direction mandated by Piaget and Vygotsky, creating constructivist platforms for learning. Piaget believed that learning only occurs in social situations, and that even the development of logical mathematical thought necessitates interactions that cause a disequilibriation of the child's egocentric conceptualizations "and in the provision of feedback to the child" (Lehtinen et al., 1998, p. 9). As for Vygotsky, "the fundamental assumption of the developmental perspective on cooperative learning is that interaction among children around appropriate tasks increases their mastery of critical concepts" (Wilcox & Williams, 1997, p. 346). This is especially true if the children in collaborative groups have different levels of expertise, creating instances of the creation of zones of proximal development within the group. One study found that when students of varied abilities were placed in groups in order to solve problems together, the process "not only increased student achievement but also increased student self-concept and social skills" (Wilcox & Williams, p. 346). Such collaborative groups have been found to "mirror the world in subtle and persuasive ways" (Wilcox & Williams, p. 353).

In CSILE, the heart of the collaborative system is a student-centered database which begins empty, but "grows as students enter their text and graphical notes" (Resta et al., 1999, p. 489). Into this database, students pour "their wonderments, their questions, their theories, their knowledge goals, their learning" (Resta et al., p. 489). The presence of such a database changes the way in which teachers and students interact, as students are given more responsibility in designing and elaborating aspects of the curriculum (Resta et al.). As a result, the curriculum remains "under constant revision" and has increased "relevance to students" (Resta et al., p. 493). As a result of this development, many teachers in CSCL environments find that they need to constantly revise the curriculum. Also, the traditional nature of a curriculum, being content- or subject-based changes, with themes taking over, leading on interdisciplinary learning paths (Resta et al.). The curriculum is covered in a nonlinear fashion, as the teachers become primarily involved in designing a learning environment "which contains all the elements of the curriculum" but allows students to engage in it as they come to it, in the course of their investigations (Resta et al., p. 492). In a study of a classroom that was transformed by CSCL CSILE it was found that a teacher "had reduced the teacher-directed components of his practice down to 30% of his total classroom activity" (Resta et al., p. 490).

CSCL is further supported by social cohesion theory, which argues that students who come to identify with groups will perform better in school (Brandon & Hollingshead, 1999). Social cohesion theory argues that the source of a student's motivation to learn is his or her identification with the group "assuming that a sufficient group identity is formed by group members" (Brandon & Hollingshead, p. 113). Five elements have been found to support student collaboration in a face-to-face environment: "individual accountability, face-to-face promotive interaction, social skills, group processing discussion and positive interdependence" (Brandon & Hollingshead, p. 113). It has been found that one of the most serious problems many students face in school is anonymity. If they do not feel like their presence is important, many students fail to attend class. If, however, they are working with others in a collaborative setting, and have adopted the goals of the group as their own, then, studies indicate, they tend to show up more often (Guzdial, 2003). Moreover, if class is more than lectures, but involves interacting with other students, students feel like what they are learning is more relevant to them (Astleitner, 2002).

An important subtopic of CSCL is conversation: how does it work, what makes it effective, and how does the quality of conversation which occurs in a CSCL environment impact learning outcomes? The level of communication that is achieved in a CSCL environment "is thought to be the key to many of the gains seen in cooperative learning"

(Graves & Klawe, 1998, p. 2). The mere fact that collaboration forces students to articulate their ideas more often, improves learning. Collaboration also involves students in the process of rehearsing and practicing their skills and knowledge. One of the strengths of CSCL, as opposed to CAL, for example, is that is has the capacity to actually improve the level of discussion and conversation that occurs in classrooms and remote locations as well (Graves & Klawe). Discussion databases have been found to facilitate the improvement of discussion between teacher and students, in so far as it provides a forum where students can receive clarification of assignments, and gain clearer information on the mechanics of the course (Day et al., 2004). In order to measure how CSCL improves the level of conversation or discussion in a course, a taxonomy of types of conversation has been developed. Of the four types of conversation, dialectic and dialogue are most advanced. In dialectic, each individual advocates his or her own position, while in dialogue transforms individual thinking into collective thought (Jenlink & Carr, 1996). A good conversation moves from the level of transacting information to transcending existing mindsets: studies have indicated that CSCL assists students in moving from less to more effective manner of discussion (Jenlink & Carr).

Another possibility arising from the type of discussion that occurs in a CSCL environment is conflict. When students' views come in conflict, some positive outcomes can occur. For one thing, a student is more or less forced to bring an internal and hidden viewpoint out into the open, where it can be examined (Lehtinen et al., 1998). While there is a danger that in the context of a conflict of opinions the disagreement may be taken as a paradox and dismissed, thus canceling out potential conceptual advancement, it is also true that conflict has been found to lead to better learning outcomes. Indeed, "cognitive research on peer interaction indicates that socio-cognitive conflicts emerging in interaction situations facilitate cognitive performance superior to those of the individual" (Lehtinen et al., p. 11).

Developmental theory argues that collaboration is most effective when students are engaged in a problem-solving exercise. A number of studies have provided "compelling evidence that situations of joint problem-solving are often associated with more efficient use of higher-level skills and knowledge, including reflection, planning and metacognition" (Kaptelinin, 1999, p. 501). In one study it was found that when children and adults worked together on a problem they "displayed more anticipatory planning and more flexibility in playing a logical computer game than when working individually" (Kaptelinin, p. 501). These same participants also made more requests for information than students working alone. It has been found that when students are engaged in shared problem-solving efforts, they take more risks, and reflect on what they are doing more (Choi & Ho, 2002). They also think aloud to themselves more often, interject their own stories and experiences more readily, and stay focused on issues of relevance to them more often (Choi & Ho).

Most importantly, it has been found that students engage in more critical thinking when they are working in a CSCL environment. Generally, learning involves six increasingly difficult levels of cognitive objectives: knowledge, comprehension, application, analysis, synthesis, and evaluation (Brandon & Hollingshead, 1999). While the first three involve such simple mental tasks as memorization and translation, the latter three “represent more complex tasks, such as separating or combining concepts, and making judgments based on evidence” (Brandon & Hollingshead, p. 117), including critical thinking. Critical thinking is defined as a higher-order skill which entails evaluating arguments, and results in interpretation, analysis, evaluation and inference (Astleitner, 2002). Because the Internet itself is so full of “false, incomplete and obsolete information” some researchers argue that critical thinking is more important than ever, in CSCL environments (Astleitner, p. 1). More importantly, “it is higher level cognitive tasks that CSCL researchers have suggested are appropriate for on-line discussion-based learning” (Brandon & Hollingshead, p. 117). As a result of this, courses which involve a lot of memorization may not be appropriate for CSCL. At the core of a critical thinking environment, is “epistemic dialogue” which involves explanations and argumentations (De Vries et al., 2002, p. 64).

Various researchers have explored how to construct an environment where discussion and critical thinking improve learning (Astleitner, 2002; Chen & Decary, 2000; Conanan & Pinkard, 2004; De Vries et al., 2002; Johanning, 2000; Putz & Arnold, 2001). The community of practice is an idea which conceives of learning as a process whereby a student moves from the periphery of a group of experts to the center, becoming an expert (Putz & Arnold). Communities of practice and learning therefore “evolve around a joint enterprise that is continually renegotiated by its members” (Putz & Arnold, p. 184). In the context of such a community, teachers simply lead and/or monitor progress, propose activities, and assess the progress of the group (Talvera & Gaudioso, 2004), mostly through the course forum or email. “Builder” is an example of a mathematics-based CSCL environment in which students in remote locations engage in negotiating the requirements of an on-line game. The students who participated in the program not only showed “significant improvement in target mathematical areas” but also expressed positive attitudes toward the learning activity, “possibly as a result of its game-like nature” (Graves & Klawe, 1998, p. 8).

Though some researchers continue to argue that face-to-face contact is a necessary requirement of effective collaboration, such community of practice CSCL environments prove otherwise. It is apparent that the joint enterprise, the shared understanding of the participants as to the purpose of the project, and agreement by all to adhere to a code of conduct, precludes the need for face-to-face contact (Putz & Arnold, 2001). That the community of practice includes members who are scattered geographically, and also possibly hold diverse views on matters, also receives support from theory. Theories of distributed cognition “imply that the subject of cognitive growth is a community of inquirers or a socio-cultural system rather than an individual agent” (Lehtinen et al., 1998, p. 12). More and more evidence indicates that the presence of cognitive diversity promotes knowledge advancement. Just as the division of labor was an important prerequisite for the growth of science, so too cooperative groups lead to knowledge advancement. That said, it is to be remembered that cooperative groups are not the same as collaborative groups. At present, the literature is parsing communities of practice for whether or not they are cooperative or collaborative. Because cooperative groups entail individuals dividing off into sub-tasks, it is acknowledged that cooperative groups may not lead to higher order thinking skills (Lehtinen et al.). Some researchers argue that one can assist cooperative groups to that end, by introducing interaction tools, while others argue that only collaborative grouping, where all members work together on a shared project, represents the true ideals of communities of practice (Lehtinen et al.).

Finally, it has been remarked that the role of the instructor should change in a true collaborative learning environment, either in the classroom or online. That is, “CSCL changes the role of the instructor from expert presenter of information to discussion facilitator and manager” which entails a different set of teaching skills (Brandon & Hollingshead, 1999, p. 121). In this context a conversational as opposed to a question-and-answer style is preferred. That said, it is important that if the teacher is designing the environment, he or she “develops reasons why students should work in groups and why those groups should use CMC technology” (Brandon & Hollingshead, p. 117). If computer use is the norm, then students will be more receptive to CSCL. If the teacher provides a strong rationale and demonstrates how “on line groups can lead to better understanding” (Brandon & Hollingshead, p. 118), students will be receptive. But if students feel that the group discussion and online work is somehow extra, and not pertinent to classroom learning, they will balk (Brandon & Hollingshead). Moreover, if the teacher selects students who are not comfortable with online discussion, or with collaborative work, progress will not be seen.

It is at the level of student receptivity that all of the ideals of researchers with regard to CSCL may come undone. Even if a CSCL creates on online problem-solving project-oriented community of practice in which those students participating do improve their outcomes, the kind of learning situation where educators can state idealistically, “the answer to the problem is secondary to what the student will learn in the subject domain as a result of trying to develop that answer" (Day, et. al, 2004, p. 16), it still remains that some students will resist using CSCL. The emergence in the literatures of an awareness of student resistance to CSCL, revealed to educators that not all is well in the environment of CSCL.

Computer-Supported Collaborative Learning: Problems with Implementation

The literature on the problems related to CSCL involves two different levels of research. On the one hand, researchers have confronted problems which have arisen in the implementation and design of CSCL systems (Conanan & Pinkard, 2004; Halloran, Rogers, & Scaife, 2001). On the other hand, studies have zeroed in on specific instances of student resistance to the use of collaborative software, in an attempt to determine why students are refusing to become engaged in collaboration. Together, these two approaches to the down-side of CSCL maps out a field that, for all of its positive rhetoric, remains in an exploratory phase.

It remains true that, in spite of "massive investments of time, effort and money" (Kaptelinen, 1999, p. 499), the impact of traditional computer-assisted learning has been minimal. It is argued by some researchers that the limited impact of computer assistance in education is due to unchanged assumptions about the nature of learning. Generally, educators continue to see learning as a process that "takes place within or around isolated individuals" (Kaptelinen, p. 499), a premise that continues to be in direct opposition to the premises of constructivist theory. The idea that learning is a social process has “not influenced the design of computer-based learning systems” (Kaptelinen, p. 499).

Following upon this finding, many of the problems which CSCL is experiencing have also been attributed to the lingering on of traditional premises even in a new technological setting. Most CSCL systems were developed in the context of a classroom, and many ask teachers to intervene in ways that, while they may be helpful in the classroom context, do not help students when they are located at home (Chen & Decary, 2000). Most of the pedagogies that are currently used in online learning remain “similar if not identical to those typically employed in face-to-face instruction” (Johanson, 2002, p. 1). Indeed, the “teach and test ontology and the reliance on traditional subject mater ontologies ensure a lack of innovation in online learning” (Johanson, p. 1). Related to this problem, is that teachers continue to act as they would in face-to-face situations, when online. They continue to instruct students about content, and have not switched over to a problem-solving pedagogy that works better in the CSCL context (Johanson). For those who believe that problem-solving is the “only legitimate kind of learning” that should take place on CSCL, this disconnect is primarily responsible for the problems encountered in CSCL (Johanson, p. 6).

While many researchers argue that CSCL must distance itself from the influence of face-to-face classroom learning, others approach the gap from another direction, claiming that classroom discussion offered “multiple opportunities for immediate two-way communication” (Perreault, Waldman, & Zhao, 2002, p. 314) that CSCL environments do not, unless a teacher makes “a special effort at the start of the…course to build an effective communication framework" (Perreault et al., p. 314), a skill that many teachers simply do not have. The fact that many CSCL programs continue to operate with a limited number of computers (if staged in schools), that "everyone is doing something different" (Olson, 2000, p. 1), and that the classroom with CSCL becomes "more complicated, albeit more stimulating" (Olson, p. 1), also makes high demands on teachers to facilitate proper implementation. If, in order to maintain order, teachers fall back on such earlier forms of media as videotape, students will only "resent the virtual and passive world it represents" (Olson, p. 2). These problems are exacerbated if CSCL program is designed for classroom use, and most students using it end up at home, where they generally give freer reign to their curiosity and interest about the world (Chen & Decary, 2000).

Another problem in CSCL is that simply making a program into an effective learning system presents schools and teachers with considerable hurdles. Not only must a way be found to give all students broadband access, but teachers must be trained, and high quality resource materials found and implemented (Trotter, 2001). Though it remains "all too common to hear academics talk glibly about putting their lecture course on the Web" it is also "sadly all too common to find teaching materials designed for a different delivery medium dumped on the web" (Ngor, 2001, p. 53). Not only must course content be thought out, so that it accommodates a hypertext structure, and offers possibilities for collaboration, but students generally are "not ready to use the information technology available to construct knowledge and exchange ideas in a virtual environment" (Ngor, p. 53). If a CSCL effort is launched with poor implementation by the teacher and little ability to use it by the student the inevitable result will be failure.

An example of how limited current use of functions in CSCL remains is in the area of document sharing. Although many different kinds of document sharing applications have been created and are on the market, it remains that most people share files by emailing them back and forth as attachments (Kay, 2004). One researcher remarks, "While this has been surprisingly productive for many people, it's a long way from collaboration" (Kay, p. 42). Moreover, because all users must install a "variety of programs and utilities on their PCs" (Kay, p.42), it continues to remain "remarkably difficult for a group of users to work together on a project" (Kay, p. 42). Of those products, moreover, while it is true that many companies have tried to produce and market collaborative software, many use very different models and approaches, and, generally, "no one has yet reached the goal of seamless, transparent, hassle-free collaboration between groups" (Kay, p. 42). That technology limitations, against theoretical ideals, play a part in student resistance to CSCL, is indicated by the results of a study which found that overall students felt their online experience was productive, but criticized the "lack of guidance in web design production skills, and planning for technology failures" (Ngor, p. 55). This is often the teacher's fault, especially in scenarios when the teacher has not properly adjusted to the new environment and remains at the center of the discussions (Astleitner, 2002). It has been found that when teachers move to CSCL but remain with a teacher-centric sense of their role, they often become overwhelmed by the responsibilities of managing a CSCL environment (Astleitner, 2002). This is especially true in multimedia CSCL environments, where working memory is severely taxed, resulting in “the problem of cognitive overload” (Astleitner, p. 123). Indeed, even students, when they are unfamiliar with the CSCL environment, will experience a decline in achievement, as compared to their classroom levels of scoring on paper tests (Astleitner). Technology limitations alone can sabotage the educational gains hoped for by CSCL, in terms of student participation and achievement.

An added problem which contributes to student failure to engage CSCL is that “collaboration remains a nebulous concept” (Walther-Thomas, Korinek, & McLaughlin, 1999, p. 20), and that making it work remains a serious challenge. Some researchers argue that CSCL is beneficial to students because it reduces many of the barriers to participation that cause problems foe students in classrooms. In one study it was found that the “salience of status and demographic differences among individuals” (Brandon & Hollingshead, 1999, p. 121), where, for example, one’s status in class determines how much one answers, is lessened in a CMC environment. Another finding was that CSCL works best when peers are online, helping one another (Walther-Thomas et al.). Indeed, “most educational professionals agree that collaboration is a worthy goal” (Walther-Thomas et al., p. 1). That said, it is also increasingly acknowledged in a generally more realistic assessment of CSCL, that “collaborative relationships in school are difficult to develop and even more challenging to maintain” (Walther-Thomas et al., p. 1). Moreover, others have found that “collaboration itself does not guarantee improved learning” (Katpelinen, 1999, p. 501). One study found that it is not so much that students are collaborating, but how they collaborate. The study found that, in comparing pairs of students working in a CSCL environment, those students who made better use of summarizing, elaborating and conflict-resolving modules, or, indeed, experienced more conflict in their collaboration, experienced better learning outcomes (Kaptelinen). Given findings like this the focus of the literature has shifted from naïve promotion of collaboration per se, to “finding suitable ways to foster online learning communities” (Putz & Arnold, 2001, p. 183).

A most important area of concern for educators is the impact of CSCL on student participation in their learning. While some studies have found that CSCL increases student participation, more detailed examination of the dynamics of participation have found some disturbing gaps and failures. For every satisfied learner in CSCL, apparently, their remains those students who simply fail to connect with the program.

One of the main problems which CSCL had hoped to alleviate was the problem of the lurker. In classroom situations, even experienced teachers have problems getting lurker students involved in discussion (Dede, 1999). Students who lurk are “awake and listening but do not become actively involved unless forced to do so” (Dede, p. 3). When they are forced to make a comment, they do so, but then “relapse into silent observation” (Dede, p. 3). Because, it has been hypothesized, “these students do not feel authentic when communicating in face-to-face group discussion” (Dede, p. 3), it was hoped that CSCL would alleviate their problem. But findings indicate that, for every media provided through CSCL, some students participate, and some others continue to merely lurk (Dede). Even such highly-touted communicative tools as threaded discussions are characterized by a limited number of students who monopolize the conversation, and others who lurk (Perreault et al., 2002). Another study found that, in CSCL, it often happens that students have to spend so much in an interpersonal mode that it often "comes at the expense of a person's attention to their private channel" (Sfard & Kieran, 2001, p. 14), a situation that can often lead to disconnection from the conversation.

Just as in classrooms, studies have also found that online CSCL communication is biased toward certain rules of participation. One study found that those students who contributed most often to discussion were those who contributed early in the thread (Shin, 2000). Moreover, "active responding contributed significantly to predicting final performance" (Shin, p. 53), that is, as in classrooms, participation was a measure of student achievement. When the behavior of those contributing was examined, it was found that they display more focus, and have better "well defined attended focus" (Sfard & Kieran, 2001, p. 59). Such a finding leads to the conclusion that "if conversation is to be effective and conducive to learning (in CSCL), then the art of communicating has to be taught" (Sfard & Kieran, p. 69).

The lack of social cues in an online CSCL environment has also been the focus of studies looking for solutions to poor student adherence to programs. The lack of social cues is believed to "retard the development of a sense of community and identity among group members" (Brandon & Hollingshead, 1999, p. 121). One study indicated that only when a way is found to circumvent the restrictions of limited social cues do positive personal relationships develop online (Brandon & Hollingshead). Another study found that the asynchronous nature of computer conferencing "slows the progress of online groups" and that online groups "take longer than face-to-face groups to make decisions"

(Brandon & Hollingshead, p. 121). A finding that online groups only reach two or three decisions per month cautions instructors not to expect that same rate of decision-making as in classrooms.

Nor should instructors “assume that students have the necessary social skills or communication competencies” (Brandon & Hollingshead, 1999, p. 114) they need in order to contribute effectively in CSCL. Many students will need training in group processing, and this can be done either formally or informally (Brandon & Hollingshead). A trickier problem is getting online students to develop “positive interdependence,” a factor which has been found to be a necessary prerequisite of collaborative learning. Again, students will need to be trained, using rewards and goals, in order to develop a sense of positive interdependence leading to collective goals (Brandon & Hollingshead).

Often overlooked is the simple fact that “collaboration is not synonymous with inclusion” (Walther-Thomas et al., 1999, p. 3). Often, instructors think that friendships need to be created, as a prerequisite for effective collaboration. In truth this goal causes more problems with the process. Not only should participation in CSCL be voluntary, but the participants should remain focused on the process of collaborating, rather than trying to make friends, which would derail the process (Walther-Thomas et al., p. 3).

An additional problem is that many students report being simply uncomfortable with group work, and one study of collaboration in classrooms found that many, even good students “do not work well in collaborative learning environments” (Brandon & Hollingshead, 1999, p. 119). Some students are inclined to cooperative, others work best alone. Indeed, one study found that the source of student resistance to working in a CSCL environment was rooted in their resistance to collaboration per se (Brandon & Hollingshead). When those students who resist collaboration also happen to be high achievers, the dilemma of CSCL can become quite exasperating.

Faced with such problems, researchers argue that CSCL environments must accommodate different student learning styles, and assist all students in finding their voice. More and more CSCL environments therefore are offering a mixture of channels of communication, from videoconferencing, the synchronous textual interaction, to asynchronous threaded discussions, to "websites structured around ongoing interaction experiences" (Dede, 1999, p. 2). One study found that students struggle to find voice in CSCL, and that they exhibit "very different preference patterns for the…ways of expression and communication used in the class" (Dede, p. 3). Some students prefer face-to-face, while others find virtual communicating more authentic as a medium for learning (Dede). Given these findings, a growing criterion for a well-designed CSCL course is that it include "several instructional media with different characteristics and affordances" (Dede, p. 3). This way, students can use "their most effective learning techniques" (Dede, p. 3). Such mixed media courses "have the potential for better learning outcomes for every student than comparable courses taught via any single medium" (Dede, p. 3). In such a course, "all students participated fully because each found a voice" (Dede, p. 4).

Other researchers have focused more on finding a way for CSCL to enable full and authentic discussion. Studying the meta-discursive rules that make a conversation either idle or valuable, a scenario of "true conversation" has been defined. A true conversation is "one in which each opens himself to the other person, truly accepts his point of view as worthy of consideration" (Sfard & Kieran, 2001, p. 49). In order to achieve this, students must be instructed in how to avoid "mis-interaction" (Sfard & Kieran, p. 49). This occurs when "participants do not live up to their discursive obligations and fail to follow in the interaction ritual" (Sfard & Kieran, p. 49). This can occur when the participants become preoccupied with matters that are off-topic, a common occurrence which inevitably "decreases the chance of coordinated focus…and significantly undermines the communication effectiveness of the conversation" if not totally disables it (Sfard & Kieran, p. 49).

The degree to which different elements of presentation, from videos to synchronous guidance, carry a motivational and emotional quality for students, is another underexplored issue (Astleitner, 2002). If features of the CSCL environment require limited focus, then motivation and emotional involvement drops as well, jeopardizing the continuation of the process (Astleitner). Digging still deeper into student online behavior, studies have found that when students split their attention between different screens, they learn less. Moreover, the principal of spatial contiguity has been verified in studies: that is, "students learn better when on-screen text and visual materials are physically integrated than when separated in time (Astleitner, p. 13). Temporal contiguity is also critical to learning, as students learn better "when the verbal and visual materials are temporarily synchronized" (Astleitner, p. 13). CSCL environments that have not been designed with these rules in mind will perform less effectively than others. In sum, therefore, a general agreement is emerging in the literature "among CSCL researchers that on line groups should be provided with as many groupware options as possible in terms of the number of communication channels, and the symbol-carrying capacity of the channels" (Brandon & Hollingshead, 1999, p. 120). Studies have confirmed that students use channels in many different ways, and that "online groups will be more productive when provided with multiple communication modalities" (Brandon & Holllingshead, p. 120). With regard to the symbol-carrying capacity, findings also indicate that text-based CSCL "limits the content that can be taught" (Brandon & Hollingshead, p. 120), and thus limits learning.

It follows from the above that a combination of student characteristics and technology capacity contributes to effective collaboration, and that failures of either leads to disconnection from the process. There is no easy answer, as "the unique dynamic and sometimes problematic differences between team members are what are likely to make collaborative undertakings more effective than the efforts of individuals working alone" (Walther-Thomas et al., 1999, p. 2). While this would seem to present researchers with the "nebulous" quality previously noted, some progress has been made in directing collaboration in a positive direction. For example, it is generally acknowledged that teachers must change their roles and surrender to the benefits of peer-to-peer communication, in a CSCL environment (Choi & Ho, 2002, p. 34), clearly a difficult change.

Moreover, the difficulties teachers face in managing the interaction in CSCL also affects the theoretical claim that CSCL must improve critical thinking. At present, "the research on collaborative learning, new media, and critical thinking shows no consistent findings, but it does show that preparing and managing this form of learning requires significant additional time, resources and advanced technical skills" in order to be productive, and to prevent student disconnection (Astleitner, 2002, p. 4).

The literature increasingly mandates that CSCL environments must differ from classroom teaching, and focus on critical thinking. In schools, learning is based on knowledge acquisition, and exams are taken to see if delivery of information has been successful or not (Johanssen, 2002). But while students learn math, they rarely learn how to be mathematicians, or sociologists or biologists. The most advanced claims made for CSCL is that it must abide by Vygotsky's and Piaget's theories of learning through social interaction, in order to achieve a level of collaboration that is distinct from classroom learning (Brandon & Hollingshead, 1999). Whether through mediation or modeling, or through disequilibriation, theorists argue that CSCL is the place for this type of learning and that if this type of learning is not achieved, students will disconnect.

For those who argue that CSCL must be problem-solving in its orientation, this places great demands on the CSCL systems. Even for solving a story problem effectively, a CSCL system will need to have a graphic organized illustrating the problems, a worked example of a number of sample problems, a program that estimates outcomes and parses texts, and a program "maps problem contents onto a semantic model" (Johanssen, 2002, p. 8). Even more difficult than tooling up for problem-solving, is convincing institutions that learning takes place in this manner, and is not simply a matter of delivering prepackaged knowledge.

Some studies have further shown that even when students made use of such tools as hypertext, they did not improve their critical thinking levels (Astleitner, 2002). In another study, the use of email alone was found to have no effect on critical thinking improvement. Other computer tools themselves, when not integrated into an instructional context, were also found to fail to produce improved critical thinking. Moreover, some programs have confused being critical about something, with critical thinking. Such findings place even greater pressure on CSCL, as content is not enough, and "critical thinking has to be supported by carefully designed instructional activities" (Astleitner, p. 3). Moreover, critical thinking will only emerge in students "when student are trained based on specific subskills and related instructional activities" (Astleitner, p. 3).

Finally, the technological demands of technology in CSCL impact both teachers and students, very often negatively. Many teachers, as noted, "freeze" when faced with the difficulties of CSCL and thus simply transfer their classroom methodologies to online contexts, all but guaranteeing student disconnect. Conceptualizing the meaning of internet technologies, as but a continuation of classroom learning, "forfeits their inherent potential to enhance the quality of education" (Putz & Arnold, 2001, p. 183). If the teacher fails to properly and effectively "stake out the new social territory" of the CSCL environment, then leverage on students will be lost (another study found that advances in the internet over time themselves reduced teacher leverage online as well) (Hoadley, 2002, p. 5). Most importantly, teachers must make a strong case for shifting to CSCL, and develop "reasons why students should work in groups and why those groups should use CMC technology" (Brandon & Hollingshead, 1999, p. 117). If the CSCL component of a course is perceived by students as but an extra that takes away from a competitive classroom environment, then students will be "reluctant to participate in...group discussions" (Brandon & Hollingshead, p. 118). If teachers struggle with the technology and do not manage the asynchronous and interactive aspects of the discussion, that too will inhibit participation (Chomienne et al., 1997). If the teacher is unable to find relevant information on the web, for use in the environment (a process which is, itself, time-consuming), then students may also balk (Chomienne et al., 1997). Whether or not teachers have the skills or will to design and develop collaborative learning environments remains a topic of debate in the literature (Brandon & Hollingshead). But what is becoming all too clear is that, for the student, the advantages associated with online group discussion and learning are "very personalized" (Perreault et al., 2002, p. 315), which raises a significant issue of student disconnection.

Student Reluctance and Resistance to Participation in CSCL

Having mapped out generally numerous problem areas where CSCL can go wrong, it is hardly surprising that recent studies have reported outright student resistance to engaging in CSCL, both generally and, specifically, in the area of mathematics. One study reported in detail how researchers constructed and designed a CSCL environment using Lotus Notes for students to use, and bravely predicted improved learning outcomes as a result of student use (Halloran et al., 2002). It therefore greatly surprised the researchers when "despite Lotus Notes being apparently suited to students' and tutors' needs, the students avoided using it" (Halloran et al., p. 1). While conceding that "resistance to the use of Lotus Notes for collaborative work is not a new finding" (Halloran et al., p. 1), researchers had to switch gears, to determine what were the reasons for student resistance. In another study of a mathematics program designed to help students collaborative with chemical engineers in a real world context, 40% of the math students “accepted a zero on the assignment rather than collaborate with the chemical engineers” (Guzdial et al., 2001, p. 25). These anecdotes “paint a stark picture of active resistance to collaboration” (Guzdial et al., p. 25). More importantly, studies of these students indicate that it was not that they were having trouble with technology, or with collaborating per se, but that they “simply showed no interest in collaborating at all” and “willingly accepted a decrease in their grade rather than collaborate” (Guzdial et al., p. 25). That is, “students (were) actively avoiding collaboration” (Guzdial et al., p. 25). So troubling have such results been, that many researchers have shifted the focus of their inquiries from developing CSCL to determining why students resist CSCL. As a result, numerous theories as to why students actively resist CSCL have emerged.

Overall, the conclusion of this literature is that, apart from the theoretical claims by many researchers, “CSCL is not a panacea” and that students, even when it is demanded of them, “will not necessarily participate” (Guzdial, 2003, p. 6). In studying student resistance, studies found three main reasons for lack of collaboration. These included rational student responses to the competitive conditions of the class, in which they believed the course was graded on a curve, a situation which makes it “only rational to avoid collaboration” (Guzdial, p. 5). Classroom culture also influences resistance, and “the instructor plays a very significant role in retention” (Guzdial, p. 8). Specifically, “instructor attitudes and modeling of behavior influences student perceptions about the course” (Guzdial, p. 6).

Other problems cited to explain student resistance, particularly in the case of Lotus Notes, are usability problems “with some of the Lotus Notes interfaces” (Halloran et al., 2002, p. 2). Specifically, Lotus Notes has a pull-down menu system for categorization of postings, which apparently inhibits threaded discussion. The implication is “that the behavior of the interface may have stymied student ability to organize material by topics” (Halloran et al., p. 2). More complicated, some aspects of Lotus Notes which researchers and teachers favor, such as its abilities to produce meeting minutes, “were not seen as such by students” (Halloran et al., p. 2). Looking deeper, it was found that many students simply lacked appropriate understanding of the software in Lotus Notes. More damning, given that the class itself was organized in a competitive framework, the collaborative, knowledge-sharing principles of Lotus Notes was simply experienced by students as “counter-culture” and thus they felt no incentive to learn Lotus Notes at all (Halloran et al., p. 1). The implication of this finding is that the structure and cognitive factors of the course need to be “consistent with the purposes of groupware if there is to be genuine incentive, and the groupware adopted” (Halloran et al., p. 1). Overall, however, the researchers believe that the failure of students to adopt Lotus Notes “was determined by multiple interacting factors” and this mixture of factors makes it “difficult to explain this failure in terms of a mismatch between the organizational ethos and the purposes of the groupware” (Halloran et al., p. 1). At present, “the reasons seem more elusive” (Halloran et al., p. 1).

In the case of the researchers who created a CoWeb site in mathematics for collaboration, the results, indicating that 40% of students accepted a zero on the assignment rather than collaborate with chemical engineers, lead to the conclusion that student misconception of the process, and their adherence to a belief in a competitive classroom environment, prevented uptake (Guzdial et al., 2001). This group of researchers therefore created an element in CoWeb which explicitly models how learning can be enhanced, and shows students how to have a richer experience using the system. That is, "surfacing the assumptions surrounding the tool and learning can provide a useful mechanism to improve its use and to defuse student apprehension about investing time in something whose rewards may seem very tangible" (Guzdial et al., p. 27).

While case studies indicate multiple or intangible reasons for student resistance to the use of CSCL, the literature itemizes reasons as well. The fact that students are often unfamiliar with the technology of CSCL turns out to be a common reason for resistance (Brandon & Hollingshead, 1999). Attitude about computers also influences uptake, as one study found that students with positive computer attitudes logged on more often. Also, another study found that students who were initially resistant to CSCL use, changed their attitudes once they became familiar with the technology (Brandon & Hollingshead). Another study found early resistance due to the fact that students were "not familiar with discussion databases" and found that if student progress was monitored during the transition into database use, students would make the transition (Day et al., 2004, p. 19). Other students reported that their resistance was based in such simple things as troubles they were having submitting assignments by email and locating information. Moreover, because many students simply overestimated their computer expertise, they were too embarrassed to ask for help and thus floundered (Perreault et al., 2002). Many students particularly shy away from participating in online discussion because "they were not ready to use the information technology available" (Ngor, 2001, p. 53).

A significant problem related to the failure of students to uptake use of CSCL is that most groupware programs are designed to work best when a "high percentage of group members use it" (Lehtinen et al., 1998, p. 7), therefore, achieving a critical mass of users "is essential for communication systems" (Lehtinen et al., p. 7). For all of the theoretical discussion about the need to accommodate individuals online, the fact remains if at least two persons do not log onto authoring sites, collaboration does not occur. In many groupware systems, "even one or two defections may cause problems for meeting scheduling, decision support and project management applications" (Lehtinen et al., p. 7). A more complicated issue is that some users adopt technology early, while others lag. It often happens that before the critical mass of users arrives at a CSCL site, the early adopters have already abandoned it (Lehtinen et al., p. 7).

The failure of uptake of groupware must be considered ironic, as groupware exists to make communication and conferencing easier. In this context, researchers argue that resistance can be reduced if the barriers of online communication, lacking the cues of face-to-face communication, are lowered (Perreault et al., 2002). Students have to begin to learn how to interact properly, in online contexts, for example, even the personalized response of email can be a problem, in CSCL class. This is because students have expectations that email will be answered immediately, often creating impossible demands on teacher time (Perreault et al.). Another study found that when discussions begin to involve more than a few students, they forget the thread: the introduction of learning journals, which allow students to reflect on their learning, is believed to solve this problem (Putz & Arnold, 2001). Team Building activities, such as the Opening Circle, which allows all participants to introduce themselves, were also found to reduce resistance to the anonymity of CSCL (Putz & Arnold).

A significant reason for student resistance to CSCL is that “when students begin to use an online discussion tool, they often perceive it to be a completely different social setting” (Hoadley, 2002, p. 5). If students do not develop a rapport with others, or feel involved in discussions, they are in danger of dropping out (Conanan & Pinkard, 2000). If they lack a shared concept of how to discuss or critique an issue, they are unlikely to participate (Conanan & Pinkard). Reproachable behavior online also inhibits further use, and teachers must instruct students on what is acceptable behavior even in the “flaming” climate of today’s internet (Brandon & Hollingshead, 1999, p. 116). Incorrect technology use by novices, waste of bandwidth by post excessively long postings, violation and network or newsgroup conventions, and inappropriate language, all can derail a productive discussion online (Brandon & Hollingshead). The use of metaphors related to known classroom behaviors have been found to be useful in developing a social context for online discussion (Brandon & Hollingshead). Indeed, many commercial online products use campus, schoolhouse or classroom metaphors to organize the online environment for resistant students (Brandon & Hollingshead).

Studies indicate that “groupware may be resisted if it interferes with the subtle and complex social dynamics that are common to groups” (Lehtinen et al., 1998, p. 7). As computers are “happiest in a world of explicit, concrete information,” further assistance must be added in order to negotiate the subtle social, political and economic undercurrents of group discussion. Using activity theory, researchers have constructed an activity theory-based framework which “acts as a tool for systematically organizing and relating observations at different levels of analysis” (Halloran et al., 2002, p. 10). This process also often involves scaffolding, leading students through the process of communication (Guzdial et al., 2001). These programs also ensure that the level of participation that the students engage in are “raised during the course” so that they move transitionally from low-commitment, single task-oriented input, to full participation in group assignments (Guzdial et al., p. 27).

Pedagogical agents are an important subcategory of groupware which emerged about ten years ago, and are increasingly being implemented to help students negotiate a CSCL environment (Vizcaino & Du Boulay, 2002). The Integration Kid interacts with the human student, helping him perform the functions necessary for effective collaborative communication (Vizcaino & Du Boulay). When the student got lost in any process, the agent gave clues and prompts, and proposed solutions, in order to keep the student engaged. When students wandered off topic, as happened, in one study, fourteen times, the agent found ways to lead him or her back onto topic (Vizcaino & Du Boulay). Most importantly, the agent is able to detect when the student begins to exhibit passive behavior (the prelude to logging off) and “in all occasions its interventions causes the passive student to take part in solving the exercise” (Vizcaino & Du Boulay, p. 3).

A final area where researchers are seeking ways to counteract student resistance to CSCL use is in the characteristics of the students themselves. One study that some students are simply comfortable with group work, others are not. Studies indicate that "some student resistance to use of groupware (is attributable to) general preferences against working in groups or a lack of comfort in sharing information with others" (Brandon & Hollingshead, 1999, p. 119). Another study compared the attitudes of extraverted versus introverted students with regard to forum comfortableness. The first finding found that "student willingness to contribute in the forum impacts on the quality of the postings" (Ellis, 2003, p. 102). Moreover, the study found that students best suited for online discussion are those "who need time to think and reflect before responding to questions" (Ellis, p. 102). This category often includes reticent students who do not do well in classroom settings. Extraverts (as measured by the Myers Briggs type scale) often are found to be too impatient for computers, and get frustrated. Extraverts also classify the tendency of introverts to pause before answering as a sign of hesitation and weakness (Ellis, p. 102).

Another study found that boys contribute more toward online discussion, but probably because they have more expertise and experience in programming (Bruckman, Jensen, & DeBonte, 2001). They also spend more time on programs. Nonetheless, girls often exhibit better and more productive behavior in collaborative work.

Overall, student attitude is believed to be strongly related to their resistance to using CSCL. If a student has a self-perception that they are not effective in class, and enter a class convinced that they won't be successful, they often are not successful (Guzdial, 2003). Moreover, students who succeed relate their success to hard work; those who don't succeed often relate their failure to luck or other external sources (Guzdial).

Finally, it is recommended that teachers model more collaborative behavior among themselves, in order to break the blockage of learned helplessness which too many students, thinking they won't be successful, so not asking questions which might help them, bring to the CSCL environment, causing them ultimately to resist using CSCL altogether.

Mathematics CSCL Environments and Student Resistance

Online CSCL environments such as Math Tutor, Math Forum, Geometry Tutor and Algebraland, all wound seem to benefit from the added support provided them by the context of math reform in middle and high schools in the United States (Burris, Heubert & Levin, 2004; Choumienne, et. al,. 1997; Wells, 2005; Yoshioka, Nishizawa & Tsukamoto, 2001). Until recently, all students in middle and high school were tracked according to their skills in math (Burris et al.). In Japan, nearly all 8th grade students study algebra, while in the U.S. fewer than 25% do (Burris et al.). For African American and Latino students, even fewer 8th graders study algebra, with 13% and 12% respectively. This phenomenon can be attributed to the "faulty assumption about what portion of the student population can reach high achievement levels" (Burris et al., p. 72). Moreover, findings indicate that low-level instruction in math, focused on basic skills, low expectations, and delivered by least-qualified teachers, does not serve students well. As a result of protest against tracking, and in accordance with the new standards movements, more and more middle and high school students are being introduced to advanced math. Many school districts are developing multiyear programs to eliminate tracking in math. A study of a program which introduced accelerated math showed "extraordinary benefits" in the achievement of all students in math (Burris et al., p. 69). Moreover, as taking advanced math is a major factor in determining whether or not a student goes on to college, this reform has had a secondary effect of improving admissions to college as well (Burris et al.).

In the context of this reform, CSCL environments for math are highly desirable. Moreover, in the field of mathematics, some of the most advanced pedagogical goals of theoreticians of CSCL are being reached. Reflective learning is focused upon in programs like Algebraland and Geometry Tutor, for example (Lehtinen et al., 1998). Moreover, in math, more teachers are involved in designing sites, and creating games for their students—a situation which greatly enhances the reframing of teacher attitudes (such a problem in general CSCL environments) (Kimber et al., 2002). Indeed, while most of the pioneering CSCL environments were developed for science courses, the urgency of math educational reform has caused more development in that field of late. In the case of programs like BUILDER, it was found that the "most significant improvements (were found) in the target mathematical areas" (Graves & Klawe, 1998, p. 8). These improvements were created with student approval, as most students reported enjoying playing BUILDER. Generally, math CSCL environments tend to be favored by students if they are self-paced, and students are able to "spend as little or as much time as they want" (Carnevale, 2004, p. A320).

Math sites seem particularly keenly aware of the necessity of providing individualized exercises, to give students, especially slower learners, "the opportunity to do additional work in special sessions designed to accomplish particular learning objectives" (Yoshioka et al., 2001, p. 376). Based on their previous success, students in one environment select appropriate problems, and can take as long as they like. The Blackboard 5 internet tool appears to be popular in math because it provides quite flexible course support and allows students to "navigate to different areas, such as announcements, course information, assignments, communication, a discussion board, and groups" (Choi & Ho, 2002, p. 34).

Time spent on the problem may be a peculiar issue in math, but general CSCL input also indicates that time is a factor in whether or not the students take the program seriously. One study found that if an online tutorial was too long, "teachers would balk" (Bacon, 2004, p. 29). And yet, "if it was too short, teachers and ultimately students wouldn't take it seriously" (Bacon, p. 29).

A CSCL program designed specifically for math is the Cognitive Tutor. The environment was created, according to constructivist pedagogy, on the findings of a survey which indicated that students were "tired of contrived problems" and were "much more interested in calculating the life span or a threatened rain forest than in solving meaningless equations with no context" (Hubbard, 2000, p. 82). While classroom mathematics often starts with an "unknown point to reach a known goal" (Hubbard, p. 81), studies have found that students were more successful at math problems if they "had solid numbers for their starting point, but did not know the ending point" (Hubbard, p. 81). Students preferred word problems to purely abstract ones. The Cognitive Tutor was therefore developed, based on the learning profile of its users, to deliver real world problems as favored by constructivist pedagogy. In courses that use the Cognitive Tutor, the students spent 40% of their time in CSCL, the rest in textbooks, thus, “students come to understand that algebra is an abstract tool that can be useful in many different contexts” (Hubbard, p. 82). The results of the use of the Cognitive Tutor were positive, with attendance increasing on days its was used, and students who used the program outperforming similar students in traditional courses, with achievement gains of almost 2% in skill and 19% in problem-solving (Hubbard). The Tutor’s success is partly attributable to the fact that includes many of the features recommended by researchers to ameliorate student resistance and prevent student dropout. In it, the teacher is no longer the sage on the stage, but guides students transitionally through increasingly difficult stages. When a mistake is made or problem encountered, the CSCL environment gives the students clues “for rethinking the problem so that he or she can get back on track” (Hubbard, p. 82). If the problem becomes insurmountable, the computer does not give the answer, but by this time the student knows that he or she is able to ask the teacher for help all along the way (Hubbard).

Another frontier that math CSCL is involved in is the use of writing as a support for learning math. The theory behind the use of writing is that students must become active in their own understanding of math, and writing helps them reflect on and offer different solutions to math problems (Johanning, 2000). As part of the “writing to learn” movement, it is believed that writing will help students create ideas, improve math fluency, and reflect on solutions in ways that offer other answers, thus deepening their math knowledge. Writing has been implemented in math classrooms in a variety of ways, including “journals, reports, essays and expository writing’ (Johanning, p. 153). Writing has also been shown to help in problem solving exercises. In one study students wrote in isolation and then discussed their ideas about solving a problem. In the group discussion, students are “given the opportunity to talk about their mathematical understandings” and whatever problems arise in the conversation also “constitute occasions for learning mathematics” (Johanning, p. 153). The writing samples in this project confirmed the literature in showing that student math thinking was diverse, and students ‘brought a variety of ideas and interpretations to the classroom” (Johanning, p. 158).

Once again, this procedure, in accordance with the literature on how best to prevent student resistance to CSCL, provides feedback, guidance, scaffolding, and ways to stay on track.

While most of the examples of CSCL in math in the literature are of a positive nature, most likely because it appears that they have already incorporated recommended elements for preventing student resistance, some problems are still noted in the literature on math CSCL. One study analyzed how focused participants in one group problem-solving discussion were, and whether or not they stayed on task or became preoccupied with other elements during a mathematical conversation (Sfard & Kieran, 2001). The authors of the study believed in the importance of conversation, basing their arguments on Vygotsky and Piaget. Studies which indicate the benefit of students verbalizing vocally their mathematical thinking, also supported their claims. The importance of mathematical communication, as opposed to simply silently working on problems, has been a major trend in math education in schools recently (Sfard & Kieran). Nonetheless, the study indicated to the researchers that “the merits of learning by talking cannot be taken for granted” (Sfard & Kieran, p. 58). This was because “the interaction between the two boys (involved in the collaboration) was unhelpful to either of them” (Sfard & Kieran, p. 58). Their communication was ineffective, and unfocused, and lacked effort. As a result, the expected synergy to be derived from collaboration, ended up as entropy. The results lead the researchers to the conclusion that “the road to mutual understanding is so winding and full of pitfalls that success in communication looks like a miracle” (Sfard & Kieran, p. 58).

The particular relevance of this finding is that, if communication in general is particularly difficult to achieve, “in math it is really an uphill struggle” (Sfard & Kieran, 2001, p. 56). The “scarcity of perceptual mediation, and the inherent polysemy of mathematical symbols, can only be outweighed by extreme concentration” (Sfard & Kieran, p. 58). Thus, interaction with others can often be counterproductive. Keeping a conversation or collaboration going, is often difficult when one is trying to solve a problem. This is “probably why mathematics made its name throughout history as an activity for loners” (Sfard & Kieran, p. 58). Because of this, strong motivation is needed, in order to make math conversation and collaboration work online successful.

Summary

This literature review has examined the successes and failures of computer-supported collaborative learning, both in pedagogical terms, and with an ultimate focus on the peculiar problems related to mathematics. The literature generally finds much to be positive about, in the introduction of CSCL in learning, but instances of case studies where researchers constructed elaborate CSCL environments, which students then refused to use, has shifted the focus of the literature onto why resistance and reluctance to use CSCL occurs in students (Brandon & Hollingshead, 2001; Choi & Ho, 2002; Crawley, 2004; Day et al., 2004; Dede, 1999; Graves & Klawe, 1998; Guzdial, 2003; Halloran et al., 2002; Lehtinen et al., 1998). Numerous reasons were found for student resistance, as well as ways to work around those problems. From these findings, a general framework emerges for what a CSCL environment must have in order to help students through the transition to full use and keep them moving through the learning process, so that they don't fall off topic and out of the course. In addition to specific helpful features that CSCL programs need, in order to reduce student resistance, other researchers are less optimistic about a quick fix and believe that the reason why students resist collaboration remains elusive (Halloran et al.).

Finally, in the area of mathematics, the field itself appears to be catching up on the field of science in developing CSCL to assist students to improve their math skills (Burris et al., 2004; Choumienne et al., 1997; Wells, 2004; Yoshioka et al., 2001). An important impetus for the development of CSCL in math is the climate of reform in which accelerated math is now being provided to all students and measured in standardized tests. In studies of CSCL math programs already developed, it has been found that some of them have achieved successful outcomes primarily because they have already incorporated elements recommended in the literature, to help students stay in the program. Nonetheless, some choice pedagogical theories for collaboration—such as collaborative conversation—may not work for math as it seems to go against the grain of the individualistic culture of math problem-solving. As in previous examples from the general literature, such problems would seem to predict future student resistance.

Chapter 3

Methodology

This chapter presents the methodology used in the study. The chapter begins with a discussion of the research design, followed by a presentation of the research questions, population and sampling, instruments, reliability and validity, trustworthiness and authenticity, data collection, data analysis, presentation of results, and resource requirements. The chapter ends with a summary.

Research Design

Traditionally, research in the social sciences has used a quantitative methodology that relies on statistical analysis of the data (Card, Moran, & Newell, 1983). Quantitative methods, with their attendant statistical analyses, have been useful in testing hypotheses about well defined problems, such as the relationship between duration of practice and efficiency of performance. However, such methods are not as well suited to the discovery of new concepts or theories or to the study of subjective states and processes such as goals, motivations, intentions, understandings, attitudes, beliefs, or emotions. Educational research problems centering on discovery or on subjective states lend themselves more readily to qualitative approaches such as interviewing, surveying, observation, and document analysis (Bogdan & Biklen, 1992; Merriam, 1991).

The purpose of the present study was to determine the reasons why participation rates in the VMT Chat program were not as high as was desired and how these participation rates could be increased. It is the belief of the researcher that a qualitative design is best suited to achieve this purpose. “The point of using qualitative means to render and interpret the educational world is that it enables researchers to say what cannot be said through numbers—or at least cannot be said as well” (Eisner, 1998, p. 187). Unlike quantitative research, in which variables are chosen beforehand and remain fixed in order to diminish the field of study (Peshkin, 1988), qualitative study is flexible in terms of its design (Eisner, 1998; Gay & Airasian, 2000), using research questions that are initially tentative and developed during the course of the study.

The qualitative methodology involved a case study that documents the issues related to participation in the VMT Chat program from February 2003 to December 2006. Yin (2003) stated that case studies are the preferred methodology when: (a) “how” or “why” questions are being posed, (b) the investigator has little or no direct control over the events of interest, and (c) the focus is on a phenomenon in its real-life context. Each of these conditions applies to the study, which: (a) is concerned with “why” participation is not optimal, (b) involves a situation in which the investigator cannot control participation, and (c) focuses on a program that is currently in use.

Research Questions

A qualitative methodology was chosen because it best addresses the following three research questions:

1. Given that an acceptable number of students are using The Math Forum's online CSCL component PoW, why have students failed to register and participate in the new VMT Chat program offered by The Math Forum?

2. What will motivate individual problem solvers, who currently participate in PoW, to register and participate in VMT Chat and become collaborative problem solvers?

3. After implementing the motivators, as suggested by the data, will the number of registrants for and participants in the VMT Chat increase?

Population and Sampling

The most basic decision in a qualitative study is the selection of participants (Johnson, 1990). Whereas a probabilistic sampling method is employed in quantitative research, a nonprobability sampling method is appropriate for qualitative research. According to Johnson:

> Probability sampling, under optimal conditions, yields the researcher a representative picture of various features of the population. Given valid theoretical assumptions, nonprobability sampling yields a small number of informants who provide representative pictures of aspects of information or knowledge distributed within the population. (p. 23)

In this type of sampling, participants are selected on the basis of their "theoretical qualifications in terms of such things as status, role, position, expertise, category or subgroup membership, dimensions, and even knowledge" (Johnson, 1990, p. 38).

The population in this study is high school students who have participated in the PoW and/or VMT Chat or have visited The Math Forum site. The selection of participants (the sample) includes a sufficiently broad range of individual high school students with different levels of computer expertise and mathematical abilities to warrant generalizations about this population.

The researchers at The Math Forum have an established database of PoW and VMT Chat registrants and participants. Since the VMT Chat has not had a substantial number of registrants and participants, approximately 5 to 10 registrants per session and approximately 4 participants that actually participate in the session, the number of interviews are relatively low with only 10 interviews conducted. This database contains the student's name, age, location, school, and grade. The Math Forum researchers determined which students meet the requirements in the study, such as grade level and whether they have participated in a VMT Chat session. They made initial contacts to gather an appropriate sample of participants for the interviews. The researchers contacted a random sample from the selected students through their e-mail accounts and requested the interviews. Once the student agreed to participate the researcher used the student's AOL Instant Messenger screen name to initiate the 10- to 15-minute interview.

The researcher's role was minimally intrusive with the students because electronic questionnaires were used to gather information from them. E-mail contact was available should the students have questions or wish to explore further the goals of the study or the topic of transformative learning communities at a distance. None of the students chose to use this resource.

In all interactions with the participants, respect and inquiry were used in order to ensure that there was open communication, a shared understanding of, and an agreement about both the study’s processes and its goals. It was made clear that participation was voluntary and the identities of the participants would be kept private.

Instruments

In the qualitative aspect of a study, the researcher is the primary instrument (Bogdan & Biklen, 1992; Eisner, 1998) and must interact with the participants of the study (Merriam, 1998). Additionally, this case study used online questionnaires, interviews, and archival records. Questionnaires and interviews are two of the most important sources of case study information and can take one of several forms, including open-ended, focused, and structured (Tellis, 1997). The researcher used an open-ended interview to ask for participants’ views on events and facts, as a means to add depth to the data gathered by the questionnaire. The archival records include VMT Chat meeting notes, The Math Forum chat logs, and registration information. The researcher was meticulous in determining the origin of the records and their accuracy. Each of the instruments is discussed in more detail below.

Questionnaires

Questionnaires offer an objective means of collecting information about people’s knowledge, beliefs, attitudes, and behavior (Oppenheim, 1992). The researcher-developed questionnaire for this study is based on a review of the relevant literature. An interview with two experts on computer-based distance education, collaboration, adoption of technology, and the experts’ personal involvement in The Math Forum at

Drexel University also facilitated the development of the questionnaire's items and their wording. These experts were asked to review the questionnaire and provide recommendations for its improvement and finalizing.

The questionnaire was used to collect data from students who have participated in PoW and/or VMT Chat. It includes both the closed-ended (multiple-choice) items and open-ended items, which permit responses in participants' own words. The questionnaire includes items related to demographics, skill level in computers and communication over the internet, educational experiences, and participants' views on the advantages of online collaboration (Appendix A).

Interviews

Merriam (1998) stated that interviewing is a relevant and powerful research tool for case studies: "Interviewing is the best technique to use when conducting intensive case studies of a few selected individuals" (p. 72). Further, according to Eisner (1998), "We need to listen to what people have to say about their activities, their feelings, their lives" (p. 183). Rubin and Rubin (1995) regard interviewees as "conversational partners" (p. 11), and talking to people is perhaps the most obvious means of learning about their perceptions, understandings, likes, and dislikes (Appendix B).

Discourse between speakers has methodological face validity because each relies on it to understand and predict the behavior of others. Face validity pertains to whether the test "looks valid" to the examinees who take it, the administrative personnel who decide on its use, and other technically inexpert observers (Anastasi, 1988).

Interviews have two key strengths as a research tool. First, interviewing permits the researcher “to enter into the other person’s perspective” (Patton, 2002, p. 341). Interviews also allow the researcher to immediately follow-up on answers given by the participants, while simultaneously seeking clarification (Marshall & Rossman, 1999). These approaches contrast with survey-style interview methods that stress problems of standardization, i.e., “how to ask all respondents the same question and how to analyze their responses with standardized coding systems” (Mishler, 1986, p. 233).

It should be noted that the process of gaining access to volunteers involved a degree of self-selection that may bias responses. The participants’ attitudes about mathematics, computers, their computer skills, working collaboratively, and the degree of trust and confidence they feel during the interviews also will influence the information they provide (Jones, 1985). The accuracy of interview statements depends on the extent to which participants tend to distort past events, echo received opinions, or conceal limitations of their knowledge.

All interviews were analyzed by the researcher. First, the researcher reviewed the answers from all of the participants. Second, the researcher reread the answers with the intent of looking for themes in the answers to each of the questions. Third, the researcher revisited these themes, to determine which research questions they address, and organized the themes by research question. Finally, the researcher developed narrative statements in the form of specific or general descriptions that address the research questions.

Archival Records

Several types of documents were obtained from The Math Forum, including VMT Chat meeting minutes, The Math Forum chat logs, and registration information. These documents were examined qualitatively and quantitatively, i.e., they were reviewed and relevant information was extracted and organized into two clusters corresponding to the first two research questions. Specifically, information on why participation rates are low were placed in one cluster, and information on how participation rates can be improved were placed into a second cluster. Registration information was analyzed to look for trends, such as whether participation has increased or decreased over a certain time period.

As a final part of the process, the researcher invited two colleagues to review the findings of the case study and its implications. Their feedback and questioning of the researcher’s assumptions was instrumental in confirming and expanding both the discussion of the data and the implications.

Reliability and Validity

Before presenting data collection, it is useful to discuss the issues of reliability and validity, as well as trustworthiness and authenticity. In case studies, data collection should be treated as a design issue that will improve the construct and internal validity of the study, as well as the external validity and reliability (Yin, 1994). According to Yin: (a) construct validity establishes correct operational measures for the concepts being studied, (b) internal validity (for explanatory or causal case studies only) establishes causal relationships to show that certain conditions lead to other conditions, (c) external validity establishes the domain to which a study's findings can be generalized, and (d) reliability shows that the operations, such as data collection procedures, can be repeated.

Construct Validity

Construct validity depends on subjective or professional judgment (Waltz & Bausell, 1983) and is the subjective decision of experts about the degree of relevant construct in an assessment instrument. In accordance with expert content judges, both the questionnaire and interview were developed with oversight provided by content experts: Dr. Wes Shumar, Associate Professor, Culture & Communication, Drexel University and Dr. Gerry Stahl, Associate Professor, College of Information, Science & Technology, Drexel University.

Internal Validity

The researcher depended on peer examination of all documents to determine internal validity and strived to establish a chain of evidence determining whether the findings match with the reality of what will motivate students to register and participate in the VMT Chat sessions.

Further, internal validity of the study depends on the adequacy with which the research ensures that: (a) the statements of interview participants are accurate accounts of their experiences and of events and conditions; (b) the data used in the study are valid representations of what participants said in the interviews; and (c) the research findings are valid interpretations of the data.

The research methods provided two means of assessing the claims of interview participants. First, the researcher relied on restatement, requests for elaboration, and hypothetical questions to encourage participants to clarify their statements. This provided ample opportunity to confirm understanding of participants' intended meanings. Second, 10 members of the VMT Chat were interviewed separately, providing multiple perspectives on relationships and shared experiences.

The validity of the transcription process was strengthened by the use of AOL Instant Messenger which provided a log of each interview. The validity of the research findings as an interpretation of the transcript and the anonymous questionnaire data is supported by the triangulation of multiple data sources. A high level of triangulation is the greatest advantage of the case study design.

External Validity

External validity is more difficult to achieve in a single-case study. Because each person is unique, one does not know whether treatment effects will generalize to other individuals. External validity may not extend beyond this study. At best, it could apply to very similar programs.

Reliability

To minimize errors and biases in the study, reliability of the study was determined by fully documenting the study through the use of a case study protocol that includes an overview of the case, general sources of information regarding the case and questions the researcher asks while collecting data during the interviews.

Yin (1994) identified six key sources of evidence for case study research: documentation, archival records, interviews, direct observation, participant observation, and physical artifacts. Not all sources are necessary in every case study, but the importance of multiple sources of data to the reliability of the study has been well established (Stake, 1995; Yin, 1994). No single source has a complete advantage over another. Rather, they are complementary and should be used in tandem. A case study should use as many sources as are relevant to the study.

Trustworthiness and Authenticity

In addition to concerns with reliability and validity, qualitative researchers are interested in establishing trustworthiness and authenticity (Lincoln & Guba, 1985). Qualitative research strategies for enhancing trustworthiness and authenticity include triangulation and thick description.

The term “triangulation,” when employed in research methodology, refers to the use of multiple sources of evidence, or multiple lines of inquiry, in addressing a particular research question (Lincoln & Guba, 1985; Merriam, 1998; Miles & Huberman, 1994; Patton, 2002; Yin, 2003). In the study, the use of multiple data sources (i.e., questionnaires, interviews, and archival data) helped to ensure the reliability and validity of the findings.

Thick description "presents detail, context, emotion [and] evokes emotionality and self-feelings . . . The voices, feeling, actions, and meaning of interacting individuals are heard" (Denzin, 1989, p. 83). Thick description provides authenticity and credibility as well as transferability to other settings (Lincoln & Guba, 1985; Merriam, 1998). This study determined thick description by the interviews conducted.

Data Collection

Prior to obtaining any contact information for the interviews, the researcher complied with the University's human subjects requirements and filed a Parent/Guardian Consent for Participation form. The form was approved by Nova Southeastern's Institutional Review Board on June 16, 2006. Participants were notified that completing and submitting the questionnaire constituted their informed consent to be included in the study.

The online questionnaire was administered to high school students who have participated in PoW and/or VMT Chat. These students were recruited from The Math Forum Web site by means of an advertisement (Appendix C) on the PoW site.

Teachers and/or students who have been participating with the Virtual Math Team at Drexel University, by either the teacher instructing their students to participate in the VMT Chat or the student taking the initiative to participate, was asked by the researcher if the researcher may or may not interview the student(s). At that point the researcher asked the teacher or the student to distribute the adolescent and parental/guardian consent forms to the parents/guardians of the student(s) and send the signed form back to the researcher.

After receiving the consent forms, at a specified Drexel University location, a time was coordinated through the researcher and the individual student to conduct the interview using either telephone communication or AOL Instant Messenger. The student(s) were asked a series of questions regarding their experience in the online collaboration.

The confidentiality agreements were destroyed at the end of this study. Only the participant's age, grade level and gender were used in the data.

Data Analysis

The usual standards of scientific inquiry and scholarly publication require that the processes and findings of research be presented in such a way that an informed audience can judge their value. For the qualitative researcher, these standards necessitate an obligation to document as clearly as possible how data were collected and analyzed, as well as how specific interpretations were justified (Kirk & Miller, 1986).

Collection and analysis of data often occur simultaneously in qualitative research (Creswell, 1994; Huberman & Miles, 1994; Marshall & Rossman, 1999; Merriam, 1998). "The function of the qualitative researcher during data gathering is clearly to maintain vigorous interpretation" (Stake, 1995, p. 9). However, at some point, data collection needs to come to an end. Lincoln and Guba (1985) offer strategies to determine when to stop data collection, including noticing that no new information is offered from the data or that new information is irrelevant to already established categories. LeCompte and Goetz (1984) noted that data collection might conclude simply when time and resources have run out.

In the present study, questionnaire and interview data were examined in the following way. To describe the participants, frequencies and percentages were computed for gender and grade. Additionally, a questionnaire (Appendix A) was used to indicate the most important reasons why the non-participating students have not participated. The student interviews provided data on the reasons that students have participated in VMT Chat. Student responses both to the questionnaire and the interview questions were organized thematically. This thematic analysis yielded a list of motivating factors.

According to Marshall and Rossman (1999), during the analysis phase the researcher is, "guided by initial concepts and developing understanding, but shift and modify them as…[the researcher] collect[s] and analyze[s] the data" (p. 151). The researcher used Creswell's (2003) six steps of qualitative research analysis for this phase of the study.

The first step of the analysis process is to organize and prepare the data for analysis (p. 191). For each recorded participant interview, a transcription of the interview was made for use in later phases of the analysis process. The transcription and the researcher notes of the interview were reviewed and a summary report was created for each participant.

The participant’s online anonymous questionnaires were also collected and reviewed. Various emerging patterns were identified and either confirmed or rejected as the collection process continued.

During the second step, which is to obtain a general sense of the data (p. 191), the researcher reviewed all the interview summaries and questionnaires numerous times. During each review phase, the researcher took notes regarding patterns and questions that arose. These notes were kept both in a journal and noted in the margin of the summaries.

The researcher discussed the data with members of the dissertation committee, as well as members of the Virtual Math Team, Dr. Stahl and Dr. Shumar. During this step, the goal was to begin to reflect on the meanings and patterns that became evident (Creswell, 2003). Marshall and Rossman (1999), state that:

> The process of category generation involves noting patterns evident in the setting and expressed by participants. As categories of meaning emerge, the researcher searches for those that have internal convergences and external divergence (Guba, 1978). That is the categories should have internally consistent but be distinct from one another. (p. 154)

During this step, and throughout the data analysis process, the data were questioned, sorted, and analyzed simultaneously. The data collected through different methods added information about how various elements of the study affected one another.

Step three is the beginning of the coding process (p. 192). "Coding data is the formal representation of analytic thinking…The researcher…applies some coding scheme to the categories and themes…" (Marshall and Rossman, p. 155) that have previously been generated. The coding may take the form of "key words, colored dots, numbers" (p.155) or whatever works to best sort the information.

This coding process is an external map of the mental process that the researcher underwent as the information was sorted and resorted to discover how the various elements interrelated. The researcher created charts and graphs for this case study to examine and re-examine the data in different frames. The researcher and her committee kept up an ongoing conversation.

Step five is the process to begin to put these discoveries into a coherent narrative. Creswell (2003) suggests that many qualitative researchers use figures, graphs or table to visually present the material along with the narrative description.

A draft of the findings and the implications were shared with Dr. Stahl and Dr. Shumar of the Virtual Math Team. Two others, as independent peer reviewers, also read either the draft findings or the whole dissertation. They were colleagues who are familiar with online collaboration, learning communities, and distance education. (Creswell, 2003) They provided feedback “about the qualitative study so that the account resonate[d] with people other than the researcher" (Creswell, 2003, p. 196). Two other colleagues unfamiliar with the topic read the findings and discussion chapter and asked critical questions that uncovered unconscious assumptions or blind spots that may have affected the way the researcher viewed the data. The results of this peer review process helped to strengthen the dissertation by validating the data and the finding, clarifying assumptions and by suggesting future research areas.

Step six involves making an "interpretation or meaning of the data. ‘What were the lessons learned’ captures the essence of this idea (Lincoln & Guba, 1985)" (Creswell, 2003, p. 194). The interpretations were derived from the researcher’s understanding of the literature and the information gathered during the study. According to Creswell the findings may be presented as new findings, or findings that are supported within the literature, or as divergent from the pattern noted within the literature. In this case study the feedback from peers and study participants have helped to mold the understanding of the findings and the discussion to inform the implications.

Overview of Statistical Analysis

The statistical procedures used to analyze the data obtained from the questionnaire included descriptive statistics, correlations, and multiple regression. This section reviews the reasons for selecting these procedures and details the criteria that guided their execution. Since this research incorporated the entire questionnaire population, sampling procedures were unnecessary. Where applicable, the research question is stated followed by a description of the statistical procedure utilized.

Descriptive statistics give a picture of the properties of samples or, where the complete data are available, a population (Ferguson & Takane, 1989). Ott (1992) noted that a common presentation includes the calculation of numeric statistics such as frequencies and percentages that are displayed in tabular format. More specifically, frequency and percentages are often portrayed in measures of central tendency and measures of variability (Gall et al., 2003).

In this study, respondents completed a demographic section that served to describe the characteristics of the questionnare population. The researcher employed descriptive statistics to present the results of these responses.

Presentation of Results

The first research question concerns the reasons for the less than desired participation in VMT Chat. To address this question, data was drawn and analyzed from archival data and the questionnaires. The resulting statistics consisted of: (a) total number of students participating in PoW and VMT Chat by semester and (b) the number of events in PoW and VMT Chat per student by semester. Descriptive statistics (i.e., means and standard deviations) are presented in a tabular format.

The second research question concerns how participation rates in VMT Chat can be improved. This information was derived from the questionnaire, interviews, and archival data. Information obtained from the qualitative data (i.e., responses to open-ended questions on the questionnaire, student interviews, and a review of archival documents) is presented in a narrative format, while quantitative information (i.e., participation statistics, responses to closed-ended questions on the questionnaire) is presented in a tabular format.

The third research question concerns whether the motivators will have a direct effect in the participation rate. This information was derived from a comparison of the number of students who register and participate in the VMT Chat session(s) after the motivating factors have been implemented. The data obtained is presented in a tabular format.

Resource Requirements

The resources needed to complete this study were modest and include the instruments that appear in the appendices, access to the Internet, AOL Instant Messenger and e-mail, a statistical package to perform the data analysis, and signed consent forms from the parents or guardians of VMT Chat participants.

Summary

This chapter presented the methodology used in the study. The chapter began with the research design, including a discussion of the appropriateness of using a qualitative methodology. This was followed by the three research questions used to guide the study. The population and sampling procedure were then presented and it was noted that a nonprobability sampling method was appropriate to the study. Next the instruments, which included a questionnaire and interviews, were discussed. This was followed by a discussion of reliability and validity, as well as trustworthiness and authenticity, as they apply to this study. Then the procedures for data collection and data analysis were explained, followed by a discussion of how the results will be presented and the resource requirements.

Chapter 4

Results

This chapter presents the results of the study. The chapter begins with a description of the online questionnaire sample and the interview sample. Then, the results related to each research question are presented. The chapter ends with a summary of the main findings.

Participants' Demographic Information

Online Questionnaire

Demographics. Of the 227 individuals who completed the online questionnaire, 96 did not indicate that they were in grades 8 through 11, and were therefore excluded from the sample. The ages of the 131 8th through 11th grade students who completed the online questionnaire are provided in Table 1. The most common age was 14 years old (27.5%), followed by 16 years old (19.8%), 13 years old (18.3%), and 15 years old (16.8%), with relatively few 12 year olds (7.6%) and 17 year olds (9.9%). The majority of the respondents (57.3%) were female, as seen in Table 2. There were substantial numbers of students from each of the four grade levels, with the most common being 8th (28.2%) and 9th (28.2%) graders (see Table 3).

Computer usage. Descriptive statistics for the computer experience/skills of the online questionnaire sample were addressed next. Table 4 shows that the majority of the respondents (61.8%) rated their computer skills as intermediate, while 26.0% indicated that they were advanced. Table 5 shows that approximately two-thirds of the respondents (66.4%) indicated that they had computer access both at home and at school, with only 1.5% having access from school.

Table 1. Age Distribution of the Online Questionnaire Sample (N=131)

Age	Frequency	Percentage
12	10	7.6
13	24	18.3
14	36	27.5
15	22	16.8
16	26	19.8
17	13	9.9

Table 2. Gender Distribution of Online Questionnaire Sample (N=131)

Gender	Frequency	Percentage
Male	56	42.7
Female	75	57.3

Table 3. Grade Distribution of Online Questionnaire Sample (N=131)

Grade	Frequency	Percentage
8	37	28.2
9	37	28.2
10	23	17.6
11	34	26.0

Table 4. Computer Skills of Online Questionnaire Sample (N=131)

You would rate your computer skills as:	Frequency	Percentage
Novice	16	12.2
Intermediate	81	61.8
Advanced	34	26.0

Table 5. Computer Access of Online Questionnaire Sample (N=131)

Do you access the computer from home or school?	Frequency	Percentage
Home	42	32.1
School	2	1.5
Both home and school	87	66.4

Table 6 indicates that nearly all (98.5%) were familiar with web browsers, and Table 7 indicates that most (87.0%) had used a web browser. Most of the students (83.2%) indicated that they used some version of instant messenger program to communicate with friends, as seen in Table 8.

Table 6. Web Browser Familiarity of Online Questionnaire Sample (N=131)

Are you familiar with web browsers such as Internet Explorer?	Frequency	Percentage
Yes	129	98.5
No	2	1.5

Table 7. Web Browser Usage of Online Questionnaire Sample (N=131)

	Frequency	Percentage
Have you ever used a web browser?		
Yes	114	87.0
No	3	2.3
Don't know	14	10.7

Table 8. Instant Messenger Experience of Online Questionnaire Sample (N=131)

Have you ever used AOL Instant Messenger or any other instant messenger to communicate with friends?	Frequency	Percentage
Yes	109	83.2
No	22	16.8

Computer games. In addition to general computer usage, the online questionnaire sample responded to questions regarding computer games. Table 9 shows that nearly all (93.9%) of the respondents indicated that they enjoyed playing computer or electronic games. Table 10 indicates that most (91.6%) indicated that they enjoyed playing computer or electronic games with other people. More than two-thirds (70.2%) of the sample indicated that they liked having a friend around when playing computer games to help them get through the hard parts, as seen in Table 11. Table 12 shows that many of the respondents (72.5%) indicated that they played computer or electronic games between 1 and 7 hours per week, with only 6.1% indicating that they played more than 14 hours per week.

Table 9. Enjoyment of Playing Computer Games of Online Questionnaire Sample (N=131)

Do you enjoy playing computer and/or electronic games?	Frequency	Percentage
Yes	123	93.9
No	8	6.1

Table 10. Enjoyment of Playing Computer Games with Others of Online Questionnaire Sample (N=131)

Do you enjoy playing computer and/or electronic games with others?	Frequency	Percentage
Yes	120	91.6
No	11	8.4

Table 11. Computer Game Assistance from Others of Online Questionnaire Sample (N=131)

Do you like having a friend around when you play computer and/or electronic games to get through the hard parts?	Frequency	Percentage
Yes	92	70.2
No	39	29.8

Table 12. Time Spent Playing Computer Games of Online Questionnaire Sample (N=131)

How often do you play computer and/or electronic games per week?	Frequency	Percentage
1 to 7 hours	95	72.5
7 to 14 hours	28	21.4
More than 14 hours	8	6.1

In summary, the information provided by the respondents regarding their computer usage and skills indicated that the students in this sample were experienced with computers. The vast majority of the sample was familiar with and used web browsers, used instant messaging services, and enjoyed playing video games. In addition, all but 12.2% of the online questionnaire sample indicated that they had either intermediate or advanced computer skills.

Work habits and online work habits. Table 13 shows the work habit characteristics of the sample. Over half of the respondents (51.9%) stated that they enjoyed working in groups, and an additional 43.5% indicated that they sometimes enjoyed working in groups (only 4.6% indicated that they did not enjoy working in groups). Two questionnaire questions addressed online work habits. Table 14 shows that approximately three-quarters of the sample (75.6%) indicated that they both talked and listened when involved in an online chat. In terms of working face-to-face or online when working with a group, 42.7% indicated that they preferred face-to-face groups while only 11.5% indicated that they preferred online groups. However, an additional 42.7% indicated that either online or face-to-face groups were acceptable, as seen in Table 15.

Table 13. Work Group Preferences of Online Questionnaire Sample (N=131)

Do you enjoy working in groups?	Frequency	Percentage
Yes	68	51.9
No	6	4.6
Sometimes	57	43.5

Table 14. Habits When Chatting Online of Online Questionnaire Sample (N=131)

When you chat online to friends, are you a talker or a listener?	Frequency	Percentage
Talker	2	1.5
Listener	5	3.8
Both	99	75.6
I don’t chat online	25	19.1

Table 15. Work Mode Preference of Online Questionnaire Sample (N=131)

Would you rather work in a group setting that is face-to-face or work in a group setting online?	Frequency	Percentage
Face-to-face	56	42.7
Online	15	11.5
Either	56	42.7
Neither	4	3.1

Based on their responses to the work habits and online work habits questions, it is clear that the online questionnaire sample enjoyed working in groups (with only 4.6% indicating that they did not), which bodes well for the potential of the VMT Chat service. Over three-quarters of the sample indicated that they were active participants, both talking and listening, when they chatted online with friends, which similarly indicates that the VMT Chat service has the potential to become popular as it requires active participation of this sort. In addition, over half of the respondents indicated that they would be willing to work online in a group setting. Therefore, it is clear from the online questionnaire responses to the work habits and online work habits questions that the VMT Chat service is feasible.

Math work habits. Several additional questions addressed how the respondents preferred to work on math homework and problems. When asked if they preferred to be alone or in a group when working on math problems, 45.0% indicated that it did not matter, while 35.1% preferred group work and 19.8% preferred to work alone, as seen in Table 16. Table 17 shows that teachers were the most common source of assistance when solving math problems (42.7%), followed by parents or guardians (20.6%). Only 15.3% indicated that they sought assistance from friends. Based on these responses, it appears that the VMT Chat program would be a viable method for students, as they are wiling to work in groups and that less than half indicated that their primary source of assistance with math problems was their teacher. As teachers are not included in the VMT Chat service, those who are adamant about requesting help only from their teachers would not be likely to use the VMT service. However, the remainder, including those who seek help from friend or others, and those who currently seek help from their teachers but may be willing to seek help from other students, represent a substantial percentage of the online questionnaire sample, indicating that the VMT Chat service would be viable.

Table 16. Preference for Group or Alone Math Work of Online Questionnaire Sample (N=131)

Do you prefer working on math problems alone or in a group?	Frequency	Percentage
Alone	26	19.8
Group	46	35.1
Doesn't matter	59	45.0

Table 17. Sources of Assistance for Math Work of Online Questionnaire Sample (N=131)

From whom do you prefer to get assistance while trying to solve a math problem?	Frequency	Percentage
Teacher	56	42.7
Friends	20	15.3
Parent/Guardian	27	20.6
Other	28	21.4

In terms of mathematics ability and enjoyment, over three-quarters of the sample (75.6%) indicated that they did well in math, and the same percentage indicated that they liked math, as seen in Tables 18 and 19, respectively. The high percentage of the sample who indicated that they did well in math and who liked math is likely to be higher than in the general population of students.

Table 18. Performance in Math of Online Questionnaire Sample (N=131)

Do you do well in math?	Frequency	Percentage
Yes	99	75.6
No	12	9.2
Other	20	15.3

Table 19. Enjoyment of Math of Online Questionnaire Sample (N=131)

Do you like math?	Frequency	Percentage
Yes	99	75.6
No	32	24.4

Over half of the respondents (57.3%) indicated that they were in an accelerated math class, as seen in Table 20. Finally, 42.0% of the respondents indicated that they preferred to solve math problems in a classroom, compared to 19.8% who indicated that they preferred to solve problems online. However, an additional 32.1% of the sample indicated that either was acceptable, as shown in Table 21.

Table 20. Math Course Level of Online Questionnaire Sample (N=131)

Are you in an accelerated math class?	Frequency	Percentage
Yes	75	57.3
No	56	42.7

Table 21. Math Work Habits of Online Questionnaire Sample (N=131)

Rather work to solve a math problem online or in a classroom?	Frequency	Percentage
Online	26	19.8
Classroom	55	42.0
Either	42	32.1
Other	8	6.1

Interviews

Ten students who participated in VMT Chat were interviewed regarding their experiences. Of these, three were female and seven were male. Three students were 12 years old, one was thirteen, five were 14, and one was 15. Four students were in the 8^{th} grade, three were in the 9^{th} grade, and three were in the 10^{th} grade. Eight of the students were participating in their first VMT Chat experience, while two had participated before. All of the students were either instructed to participate or invited to participate through their teacher/school. Only one of the students had ever participated in the Problems of the Week (PoW) program.

Findings for Research Question 1

The first research question of this study was: Given that an acceptable number of students are using The Math Forum's online CSCL component PoW, why have students failed to register and participate in the new VMT Chat program offered by The Math Forum? As noted in Chapter 3, the data for this research question came from the online questionnaire and from the student interviews.

Online Questionnaire Respondents

Problem of the Week and Virtual Math Team Chat participation. Results related to participation in the PoW are provided in Table 22. Of the 131 respondents, 31.3% indicated that they had participated in PoW, and only ten of the 131 respondents (7.6%) indicated that they had participated in the VMT Chat service (see Table 23). Of those who participated in PoW (*n*=41), however, 24.4% participated in VMT Chat.

Table 22. Participation in PoW of Online Questionnaire Sample (N=131)

Have you participated in the PoW?	Frequency	Percentage
Yes	41	31.3
No	90	68.7

Table 23. Participation in VMT Chat for Online Questionnaire Sample (N=131)

Have you used the Virtual Math Team service?	Frequency	Percentage
Yes	10	7.6
No	121	92.4

Table 24 shows the results related to instructions from the teacher regarding participation in PoW. Of those who participated in PoW (*n*=41), 63.4% indicated that they were instructed by their teacher to participate, indicating that a strong component of participation is a directive from a teacher. Of those who had participated in the VMT Chat (*n*=10), only 20.0% indicated that their teacher had instructed them to participate, as seen in Table 25. Therefore, one possible reason for adequate participation in PoW but inadequate participation in VMT Chats is that there was a higher level of teacher encouragement for PoW (63.4%) than for VMT Chats (20.0%).

Table 24. Teacher Instructions for Participation in PoW of Online Questionnaire Sample (N=131)

If you participated in the Problem of the Week, were you instructed by your teacher to participate in them? (*n*=41 who have participated)	Frequency	Percentage
Yes	26	63.4
No	15	36.6

Table 25. Teacher Instructions for Participation in VMT Chat for Online Questionnaire Sample (N=131)

Did your teacher instruct you to use the Virtual Math Team service? (*n*=10 who have participated)	Frequency	Percentage
Yes	2	20.0
No	6	60.0
Don’t know	2	20.0

Additional online questionnaire questions examined participation and non-participation in the VMT Chat service in more detail. Table 26 shows that of the 121 who had not participated in the VMT Chat, 62.0% indicated that they would be interested in using the service in the future, and an additional 33.9% indicated that they didn’t know if they would be interested. Only 4.1% of those who had not used the VMT Chat service indicated that they would not be interested in doing so in the future, which is a positive indicator of the future potential of the VMT Chat service.

Of the ten respondents who had used the VMT Chat service, 80.0% stated that they would use it again, as seen in Table 27. Therefore, among those who have not used the VMT service, a high percentage may do so in the future, and among those who have used it, most will use it again. Taken together, these two indicators show that the VMT service may well become more popular in the future.

Table 26. Future Interest in Participation in the VMT Chat Service (n=121)

If you haven't used the Virtual Math Team service would you be interested in using this service? (*n*=121 who have not participated)	Frequency	Percentage
Yes	75	62.0
No	5	4.1
Don’t know	41	33.9

Table 27. Continued Participation in the VMT Chat Service (n=10)

If you have used the Virtual Math Team Service would you use it again? (*n*=10 who have participated)	Frequency	Percentage
Yes	8	80.0
No	0	0.0
Don’t know	2	20.0

The next set of questionnaire questions examined the experiences of the ten individuals who have used the VMT Chat service in more detail. The responses to these questionnaire items are included under the first research question because the perceptions of students’ who have used VMT may shed light on why more of them are not using the program. Table 28 shows that most (90.0%) of those who had used the VMT Chat service indicated that they actively responded (70.0%) or both actively responded and let others respond (20.0%).

Table 28. Active versus Passive Participation in the VMT Chat Service (n=10)

When using the Virtual Math Team service, did you find yourself actively responding or did you hold back and let others? (*n*=10 who have participated)	Frequency	Percentage
I actively respond	7	70.0
I let others respond	1	10.0
Both	2	20.0

VMT Chat users were then asked if they found the VMT Chat service fun, easy to use, or difficult to use, and were given the choice of checking multiple options. Seventy percent of those who participated in the VMT Chat indicated that it was fun, although no respondent indicated that it was either easy or difficult to use, as seen in Table 29. Thus, despite the fact that they could have selected both "it was fun" and "it was easy to use," no respondent made both of these selections, preferring to indicate only that it was fun. Thus, it appears that the respondents did not feel that the VMT Chat service was easy to use, which may be one reason for a lack of participation, and the fun aspect of VMT Chat is one potential motivator for increased participation.

Table 29. Characteristics of the VMT Chat Service (n=10)

The Virtual Math Team service was (*n*=10 who have participated)[1]	Frequency	Percentage
Fun	7	70.0
Easy to use	0	0.0
Difficult to use	0	0.0

In terms of the preference for PoW versus the VMT Chat, Table 30 shows that more respondents (40.0%) indicated that they preferred the PoW than the VMT Chat (30.0%). One respondent (10.0%) indicated a preference for both, while two respondents (20.0%) did not know which they preferred.

Table 30. Preference for PoW versus VMT Chat Service (n=10)

Which do you prefer, Problems of the Week or Virtual Math Team service? (*n*=10 who have participated)	Frequency	Percentage
Problems of the Week	4	40.0
Virtual Math Team	3	30.0
Both	1	10.0
Don't know	2	20.0

Students were then asked why they preferred VMT Chat or PoW or both. The responses of the four students who preferred PoW and the three students who preferred VMT Chat are shown in Table 31. Those who preferred PoW over VMT Chat (*n*=4) indicated that they had this preference either because they liked to work alone rather than in groups, or because they had difficulty understanding how to use the VMT Chat service. All of those (*n*=3) who preferred VMT Chat over the PoW service indicated that this preference was due to the fact that they preferred to work in groups.

Table 31. Reasons for Preferring PoW versus VMT Chat Service (n=7)

Why do you prefer Problems of the Week? (*n*=4 who indicated that they preferred PoW over VMT Chat)
I have used both and I like the PoW to solve problems alone
I like [the PoW] because I get to solve problems on my own.
I prefer POW because the [VMT Chat] was to hard to figure out
I didn't understand how to use the [VMT Chat] service
Why do you prefer VMT Chat (*n*=3 who indicated that they preferred VMT Chat over PoW)
I like working with others in a group
I prefer the [VMT Chat] service because I like working in teams
I used both services and I like to solve math with other people. I would prefer the [VMT Chat] service

Finally, Table 32 shows that most (57.3%) of the 131 respondents indicated that they felt that the VMT Chat service could help them in math class. No respondent (0.0%) indicated that the VMT Chat service could not help them in math class, with the remainder (42.7%) indicated that they did not know. While a description of the VMT Chat service was given, most of these respondents had never used the VMT Chat service.

Table 32. Ability of the VMT Chat Service to Help in Math Class (N=131)

Do you think the Virtual Math Team service could help you in math class?	Frequency	Percentage
Yes	75	57.3
No	0	0.0
Don't know	56	42.7

An open-ended question in the questionnaire inquired as to the potential motivators for using the VMT Chat service. Table 33 shows the most common responses to the online questionnaire question related to the potential motivators for using the VMT

Chat service. The most common response was that students might use the service if they were stuck with a particular problem and needed assistance (16.8%). Representative responses in this category indicated that respondents would be motivated to use the VMT Chat service if “I needed extra help answering problems,” if “…the people could teach me how to do very hard math problems,” or if it was possible to get “correct answers to confusing problems.”

The benefits of getting feedback from peers or the interactive nature of the VMT Chat (13.7%) was also a common category of response. One respondent stated that he was “Looking forward to seeing what other students my own age can do and what we can learn from each other, and having someone to compare answers with,” while another noted that “It is nice to get other people's ideas on how to solve problems, because a lot of problems have more than one way of going about finding the answer.”

A substantial number of respondents (13.7%) also provided responses that indicated that increased publicity or advertising about the service would be a motivator, such as one respondent who stated that one way to increase usage would be “More publicity about it, I only found it through a Google search for math help” while another stated that “I never heard of it before, maybe more advertisement.” Whether awareness was to be increased through advertising or through teacher support, it appears that a substantial number of students would be interested in using the service if they were made aware of it.

Some students indicated that they would be more likely to participate if prizes were offered (6.9%) (e.g., “the I-pod kind of got my attention”) or if there was extra credit offered or a course requirement that they participate (6.9%). Regarding a course requirement, even one reluctant student stated that “If I had to do it for a grade in school. I don't like working math problems online, but if it were mandatory, I'd try my best.” A few students thought that the speed with which they could get help (4.6%) or the fact that the VMT Chat service would be fun (4.6%) would also be motivation to participate. Figure 1 shows the most common potential motivators.

Table 33. Categories of Motivators for Participation in VMT Chats from Online Questionnaire (N=131)

Category of Motivator	Frequency	Percentage
Couldn't solve a problem	22	16.8
Feedback from peers/interactive/learning community	18	13.7
More publicity/advertising	18	13.7
Prizes	9	6.9
Extra credit/required for class	9	6.9
Real time/speed of getting help	6	4.6
Fun	6	4.6
Useful/relevant/better grades	5	3.8
Teacher recommendation	4	3.1
Smart students to help	2	1.5
Free	2	1.5
User friendly	2	1.5
Other	5	3.8
Don’t know	6	4.6
Nothing	6	4.6
No answer given	11	8.4

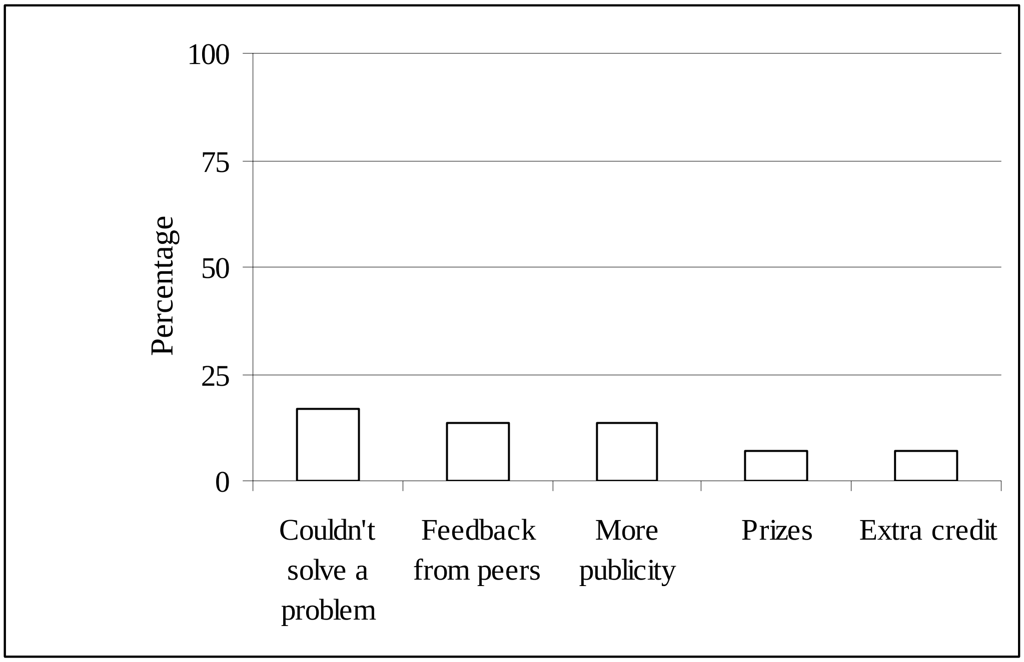

Figure 1. Bar Chart for Most Common VMT Chat Participation Motivators

Interview Respondents

In-depth interviews were conducted with ten students who had participated in the VMT Chat service. One of the interview questions relate to possible factors that would motivate the respondent to participate in the VMT Chat service. Table 34 shows the specific responses of these ten students to this interview question. Three students did not provide a specific factor that would motivate them to participate in the VMT Chat service. Of the seven who provided one or more responses to this question, four indicated that extra credit in their math course would be a motivator, and four indicated that the prizes were a motivator. Two respondents indicated that if the VMT Chat was integrated into their course work/homework assignments, they would be motivated to participate.

Table 34. Motivators for Participation in VMT Chats from Interviews (n=7)

Maybe if I could get help solving my own homework problems or I could get credit toward my grade.
I thought it was fun but it would be great to get extra credit for it. Or maybe there could be a contest with prizes for the first group to solve a problem.
Well, I'd participate just to see what it's like. And it might be interesting to see it integrated into a class curriculum.
If I could get extra credit for class or it was a contest.
Maybe if I could get more extra credit for math I would join again.
Prizes for the most collaborative group.
Well, the prize is already motivation enough, and just the experience is good.

In addition to the direct question about what could be a motivator for participation in VMT Chats, other responses shed some light on the possible motivating factors. Some of these related to improvements that could be made to the VMT Chat system, either in terms of the content of the service or the way it is used. In terms of content, one respondent stated that "I think it could use some math hints where you can go to get more help with the problem if the group can't help you," while another noted that, while he liked the service, "I did think the moderator was going to help us more."

Several respondents felt that not enough time was given to solve the problem; representative responses included a request to "give us more time to solve the problem," the statement that "It was kind of fun, [but] we didn't get a chance to solve the question." One student stated that the group left VMT Chat to continue their chat in another program, noting that “we felt that it was too short, and we wanted to find our answers that we were looking for.”

In terms of possible improvements to the way in which the program is used, one respondent suggested that we “make the software easier,” while another stated that “it was hard to get used to the controls it could be made easier.” Another participant indicated that there was a “temptation to use my own pencil and paper to explain diagrams and tables and talk instead of making use of the chat program and drawing board,” indicating that she was having difficulty with the program tools. However, other respondents seemed to like the program interface, noting that “It was fun. I liked all the different tools you could use during the chat” and “With some of the extra features, like the quoting system, I think it was a bit better than even what I imagined it to be.” In addition to software/interface issues, some respondents felt that the structure of the program could use improvement. One stated that “We should be able to form our own teams to suit this time, and to possibly discuss outside of VMT chat.”

An additional possible motivator is to emphasize the interactive nature of the VMT Chat service, and several of the interview respondents made comments along these lines, such as “I think it could help if I had similar homework problems that I could get help from a group online who had the same type of problems,” “we all had trouble with it in different ways but everyone tried to help each other,” “It was interesting trying to figure out the problem with other people.” and “It would be great if we could solve our assignments together like this more often,” “We could help each other out,” and “If can help because there is a group of us trying to solve the problem and we all help each other through it." Finally, one respondent noted that: "I like the fact that people your own age can help you with solving homework problems, especially if you have trouble in math." Emphasizing these components of the VMT Chat system may be a motivator for increased participation.

Another respondent was a repeat user, having used the service the previous year. This respondent indicated that he initially heard about the service through his teacher, and that this teacher had recommended again this year that the class use the VMT Chat service: "I had the same teacher (for math enrichment, which I took for 2 years)." This is another indication that teacher support for the project may be a key motivating factor. This respondent also noted that it was somewhat frustrating that the participants in his group were somewhat below him in terms of mathematics skill, noting that he enjoyed solving problems "with a group, but we'd all have to be at similar skill levels" and that "It'd be great if we had different levels of difficulty." Another respondent, who felt that his skill level was below that of the other group members, noted that "I think the other people knew more about the problems then me I thought it was hard." Taken together, these responses indicate that allowing for differences in skill level may be a change to the VMT Chat system that would make students more likely to participate.

Based on some of the interview responses, teacher and school recommendations to use the program appear to play a key role in student participation. One respondent was asked if he was instructed to use the program, and replied that "I wasn't 'instructed,' but my extra math teacher told us about it, and that it was a fun program." Another student, asked the same question, replied that "Rather than instructed, I was requested to participate in the VMT Chat, if I had any interest in it." Another respondent indicated that "No, we only received a school-wide e-mail about it allowing us to say that we'd like to participate." These responses indicate that even if participation is not a course requirement and if extra credit is not given, that the mere recommendation of the service from the school or teacher may have a beneficial impact on participation rates.

VMT Chat Meeting Minutes and VMT Chat Logs

The VMT Chat meeting minutes and VMT Chat logs were examined to ascertain if any information regarding why participation rates in VMT Chat were low. The meeting minutes are discussions between program staff, while the chat logs are the transcripts of the VMT Chats involving students and the moderator. The VMT Chat meeting minutes offered no information on the low participation rates. The chat logs offered two pieces of information. First, there were several comments about how fun the VMT Chat program was, and how nice it was working with other students. This indicates a certain level of satisfaction on the part of students, but does not directly relate to why participation rates in VMT Chat are low. Second, there were comments related to a desire on the part of students to have more substantive help from the chat session monitor. However, given that the purpose of VMT Chat is to have students work with each other (and not be guided by the teacher), this desire on the part of students falls outside the scope of the current study.

Findings for Research Question 2

The second research question was: What will motivate individual problem solvers, who currently participate in PoW, to register and participate in VMT Chat and become collaborative problem solvers? Nineteen students from the questionnaire were included in addressing this research question along with one student from the interviews. The subset of the questionnaire sample who (a) stated that they preferred to work on math problems alone or that it didn't matter if they worked alone or in groups (i.e. excluding only those who said they preferred groups) from Q16 of the questionnaire, (b) had participated in PoW (from Q22), and (c) had not participated in VMT Chat (from Q24) were selected. There were 19 such individuals.

Motivators from Selected Online Questionnaire Respondents

Table 35 shows all of the responses to the questionnaire item (Q25) which asked what would motivate the respondent to participate in VMT Chat. By far the most common category of response was the motivation to get help on math problems (n=9). Respondents indicated that they would be motivated if "a lot of helpful people showed up," or if "I had a hard problem to solve," or "to solve difficult problems in math." Other respondents indicated that they might be motivated if the problems were challenging, if prizes were offered for participation, if peers related that the service was good, if they wanted immediate feedback, if it was fun, or if they were required to participate.

Motivators from Selected Interview Respondents

Only one of the students (a 14 year old male in 9th grade) from the interview sample met the conditions required for inclusion in addressing Research Question 2. When asked about group work versus working alone, this student stated that “I usually try to figure the answer out myself.” In addition, the student had participated in PoW and had not participated in VMT Chat (prior to the interview). When asked what would motivate him to participate in VMT Chat, the student indicated that he would be more likely to participate “If I could get extra credit for class or it was a contest.” When asked what might improve the VMT Chat service, the respondent indicated that “It would be fun if there was some kind of contest.” When asked if he preferred PoW or VMT Chat, the respondent indicated that “I think I would rather solve math problems with other people [i.e. use VMT Chat]. It’s hard to solve the difficult math problems on your own [i.e. with PoW]”.

In summary, the main motivator for individual problem solvers who currently use PoW to start using the VMT Chat is to get help from other students. Thus, even individual problem solvers recognized the need to get help at times, and indicated that they would be motivated to use the VMT Chat service to get help from other students when they needed to get help, or when they faced challenging or difficult problems. Prizes, getting peer feedback, getting answers quickly, and having fun were also mentioned.

Table 35. Motivators for Participation in VMT Chats from Selected Questionnaire Respondents (n=19)

Category	Response
To Get Help (n=9)	If a lot of helpful people showed up
	If I can't solve problems then I would look them up
	If I had a hard problem to solve
	If I saw that I really needed a lot of help
	To solve difficult problems in math
	If it was free and useful
	If they were nice and explain in detail to me
	I think it will help me better
	Students having good mathematics skills
Challenging/Difficult Problems (n=2)	If their challenging and fun
	If you make the problems a lot more difficult, then students would probably have…the whole online community to solve problems
Prizes (n=1)	A free new video iPod
Peer Feedback (n=1)	If I heard positive feedback from my peers about the service
Speed (n=1)	Live chat so that you could work on the problem at that time instead of waiting for e-mails
Fun and Competition (n=1)	To compete and join in the fun
Mandatory Participation (n=1)	If I had to do it for a grade in school; I don't like working math problems online, but if it were mandatory, I'd try my best
Other (n=2)	It's good
	I don't know

VMT Chat Meeting Minutes and VMT Chat Logs

The VMT Chat meeting minutes and VMT Chat logs were examined to ascertain if any information regarding ways to increase participation was included. The meeting minutes are discussions between program staff, while the chat logs are the transcripts of the VMT Chats involving students and the moderator. As was the case when the meeting minutes were examined for the first research question, there was no information on factors that might motivate students to use VMT Chat. The only piece of information from the chat logs that is somewhat relevant was the desire on the part of students to have substantive math help from the monitor, but as noted above, implementing this aspect of VMT Chat would contradict the stated purpose of the program (i.e. to have students work with each other to solve the problems).

Findings for Research Question 3

The third research question was: After implementing the motivators, as suggested by the data, will the number of registrants for and participants in the VMT Chat increase? Based on the results from Research Question 2, two motivators were implemented in a 8th grade mathematics classroom in which no students had participated in VMT Chat: (a) the possibility of receiving help with homework problems and (b) getting extra credit for participating. There were 16 students in the math class. Initially, a chat session was scheduled and the teacher informed the students of VMT Chat and recommended it as a place that they could go to get help on their homework problems. Two homework problems were provided by the teacher to be included in the VMT Chat session. Of the 16 students, five (31.3%) participated after the implementation of the first motivator, as seen in Figure 2.

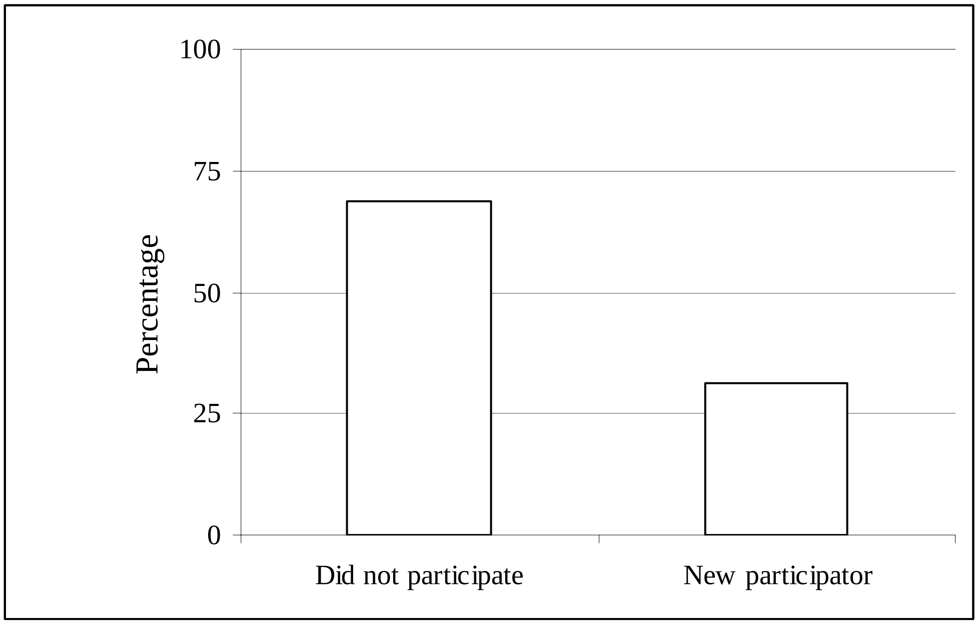

Figure 2. Bar Chart for Participation Following Teacher Recommendation of VMT Chat as a Source for Help with Homework Problems

The teacher noted in a communication to the researcher that “They seemed to enjoy the system and played around for a while. And of course they also worked on the problems; They didn't explain much when the majority of the group were OK with an offered solution. But I think they had a relatively better discussion on the second problem, mainly because they couldn't get it right away.” This indicates that the experience of VMT Chat was enjoyable for the students and that more challenging problems may be key in motivating students to participate in VMT Chat.

The second motivator to be implemented was extra credit in the math course for participation. This was offered after the VMT Chat session promoting extra help on math homework problems in order to determine if there was any additional effect of extra credit following the directive from the teacher (the first motivator implemented). When the teacher then offered extra credit for participation five of the 16 students (31.3%) participated (including only one of the five who had participated following the implementation of the first motivator), as seen in Figure 3.

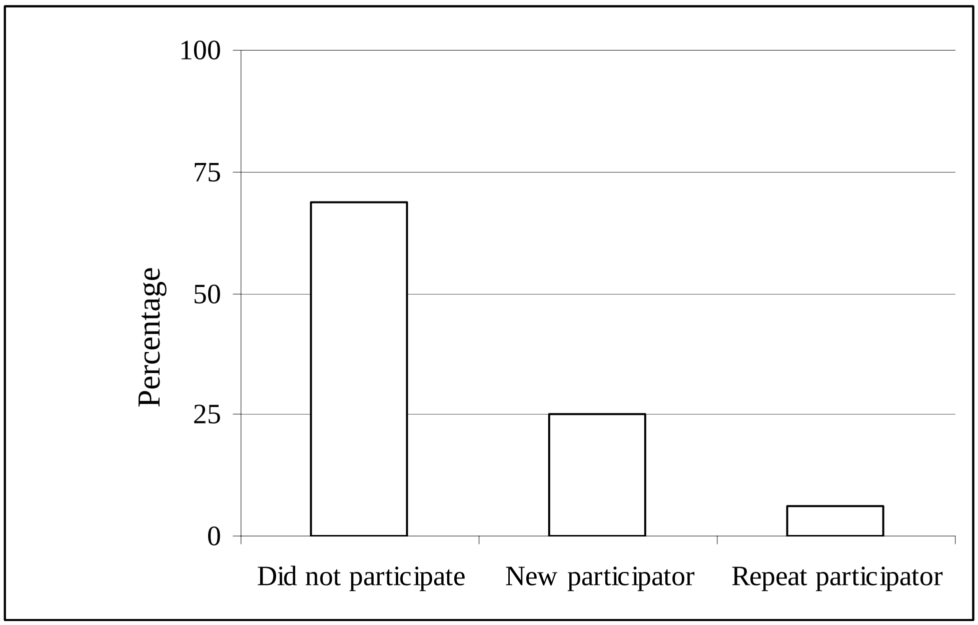

Figure 3. Bar Chart for Participation Following Teacher Offer of Extra Credit for Participation

Taken together, the motivators of having the teacher offer the service and note that it was a way for students to get help with their homework problems and then offering extra credit for their participation resulted in nine of 16 (56.3%) students participating. Thus, with the implementation of the two motivators derived from the first and second research questions, over half of the students in this classroom were motivated to try VMT

Chat. In addition, the students who participated following the offer of extra credit were different (with one exception) from those who participated based solely on a teacher recommendation to participate. This indicates that different students may be responsive to different motivators, and that a successful system for increasing participation should take into account multiple motivators.

Summary of Findings

The first research question of this study was: Given that an acceptable number of students are using The Math Forum's online CSCL component PoW, why have students failed to register and participate in the new VMT Chat program offered by The Math Forum? Results indicated that:

1. Teacher encouragement to participate in PoW was substantially higher (63.4%) than teacher encouragement to participate in VMT Chats (20.0%).
2. Among the questionnaire respondents, students stated that they would be likely to use VMT Chat if they were stuck with a particular problem and needed assistance (16.8%), if they wanted to work interactively with other students (13.7%), and if there was more publicity or advertising about the service (13.7%). In addition, prizes (6.9%) and extra credit (6.9%) were seen as potential motivators.
3. Among the interview respondents, the most common potential motivators were extra credit in their math course and prizes. Integration of VMT Chat into homework assignments was also a potential motivator, while other students suggested changes to the VMT Chat interface to make it more user-friendly, that

the program should provide more problem-solving time, or that making the VMT Chat service known (as opposed to making it a requirement or offering extra credit) may be a strong motivator.

The second research question was: What will motivate individual problem solvers, who currently participate in PoW, to register and participate in VMT Chat and become collaborative problem solvers? Results indicated that:

1. The most common category of response was the motivation to get help on math problems.
2. Other respondents indicated that they might be motivated if the problems were challenging, if prizes were offered, if peers indicated that VMT was helpful, if they wanted immediate feedback, if it was fun, or if they were required to participate.

The third research question was: After implementing the motivators, as suggested by the data, will the number of registrants for and participants in the VMT Chat increase? Two motivators were implemented based on the findings from the first two research questions: (a) the possibility of receiving help with homework problems, and (b) getting extra credit for participating. Results from an 8^{th} grade math class in which none of the 16 students had participated in VMT Chat indicated that:

1. Five of the 16 students participated after the implementation of the first motivator (a recommendation from their teacher that they could receive help from their peers in working on homework problems).

2. Five of the 16 students participated when the teacher then offered extra credit for participation.
3. In total, nine of the 16 students participated in VMT Chat after the implementation of the two motivators.

Chapter 5

Conclusions, Implications, Recommendations, and Summary

Conclusions

The first research question of this study was: Given that an acceptable number of students are using The Math Forum's online CSCL component PoW, why have students failed to register and participate in the new VMT Chat program offered by The Math Forum? Four potential reasons for a lack of participation in the VMT Chat program were found. First, there appears to be a lack of teacher encouragement to participate in the VMT Chat program. Specifically, students who used the PoW service were more than three times as likely to have been encouraged to do so by their teacher to do so than students who used the VMT Chat program. Second, some students indicated that they would be likely to use VMT Chat if they were to receive extra credit in their math class or if the VMT Chat program were integrated into their course work; the lack of extra credit or course integration is therefore another possible reason for a lack of participation in the VMT Chat service. Third, some students had a difficult time using the VMT Chat service, did not like the computer interface, or did not feel that they had enough time to solve the assigned problems, which is an indication that students may not be using the VMT Chat service because of the computer environment. This possibility is underscored by the fact that no respondent in this study responded "yes" when asked if the VMT Chat service program was easy to use. Fourth, many students indicated that they had never heard of the VMT Chat service and therefore the final reason for a lack of participation may be a lack of advertising or marketing to appropriate individuals (i.e. school administrators, teachers, and directly to students).

In addition, due to the fact that the first research question was really a comparison of PoW to VMT Chat, the fact that more students who had used both programs preferred PoW (40.0%) compared to VMT Chat (30.0%) may be one reason for a lack of participation in VMT Chat. Students who had used both programs tended to prefer PoW, and therefore may have continued to use PoW but not regularly used VMT Chat. In short, adequate participation in PoW but inadequate participation in VMT Chat may be because students who have used both services tend to prefer PoW. Those who preferred PoW over VMT Chat indicated that it was either because they liked to work alone rather than in groups, or because they had difficulty understanding how to use the VMT Chat service. Those who preferred VMT Chat over the PoW service indicated that this preference was due to the fact that they preferred to work in groups. Therefore, segmenting the population of students based on whether they prefer to work alone or in groups may be an effective way of increasing VMT Chat participation.

The second research question was: What will motivate individual problem solvers, who currently participate in PoW, to register and participate in VMT Chat and become collaborative problem solvers? The most common category of response was the motivation to get help on math problems. Other respondents indicated that they might be motivated if the problems were challenging, if prizes were offered, if peers indicated that VMT was helpful, if they wanted immediate feedback, if it was fun, or if they were required to participate. In addition, getting students to use the program once may result in subsequent participation, as 80.0% of those who used the program stated that they would use it again. While it is somewhat circular to conclude that one of the reasons they are not using the program is that they have not used the program, it nevertheless appears that if students can be introduced to the program once, repeat participation will be high.

The third research question was: After implementing the motivators, as suggested by the data, will the number of registrants for and participants in the VMT Chat increase? Two motivators were implemented based on the findings from the first two research questions: (a) a recommendation from the teacher to use the VMT Chat service for the possibility of receiving help with homework problems, and (b) getting extra credit for participating. Results indicated that 31.3% of the students (5 out of 16) participated after the implementation of the first motivator. Furthermore, an additional 25.0% of the sample (4 out of 16) students participated when the teacher then offered extra credit for participation. In total, 56.3% of the students participated in VMT Chat after the implementation of the two motivators.

Implications

One of the biggest recent changes in the field of education is the use of computer-supported collaborative learning (Kay, 2004; Kimber, Hitendra, & Richards, 2002). However, research has shown that these programs often encounter student resistance, technical obstacles, and social obstacles (Astleitner, 2002; McLoughlin & Luca, 2002). The VMT Chat program implemented by The Math Forum has experienced relatively low participation rates, and is therefore representative of the problems encountered in implementing computer-supported collaborative learning. Specifically, student resistance is implicit in the low participation rates, and the results of this study indicated that there are both technical obstacles (e.g., students had difficulty with the program interface, time constraints, and difficulty of use) and social obstacles (e.g., students who preferred the PoW program to the VMT Chat tended to prefer solving problems on their own rather than with a group). Very few published studies have empirically measured the extent of resistance or sought out specific reasons why students have resisted (Brandon & Hollingshead, 1999). The current study showed that (a) low participation rates could be understood, (b) motivators could be implemented successfully to increase participation on computer-supported collaborative learning programs. Thus, the unrealized potential of computer-supported collaborative learning programs appears to be within reach.

Recommendations

Based on the results of the current study, the following recommendations are offered in order to advance the use of computer-supported collaborative learning. First, it is imperative that teachers become involved in the process. In the current study, teacher encouragement to participate was a key component of increasing participation in the VMT Chat service. Another way in which teachers can enhance the efficacy of computer-supported collaborative learning is to integrate the program in their course work. Assigning homework problems that will be available through the collaborative program or offering extra credit for participation should be effective ways to increase participation.

While teacher involvement is a key component to the success of computer-supported collaborative learning, educational administrators have a role to play as well. Educational administrators could assist in fully realizing the potential of computer-supported collaborative learning in a variety of ways. Perhaps most important is to provide the resources necessary for the implementation of such programs. Resources should include both financial contributions such as money for more computers in the classroom, as well as providing teachers with the time they need to adequately integrate computer-supported collaborative learning in the classroom. Time resources could consist of release time for teachers to become trained in the use of programs like VMT Chat.

The results of the current study also provide recommendations for future research in this area. First, it is recommended that researchers employ a strategy similar to that in the current study wherein a programmatic (multi-stage) approach was taken. Specifically, the current study sought to identify reasons for low participation rates, to uncover potential motivators for increased participation, and to examine the effects of those motivators. Had this study been focused solely on examining reasons for low participation, for example, the utility of these results would have been limited, because whether or not attempts to address the low participation rates would ultimately be successful would remain unknown.

Second, it is recommended that future research in this area build upon the current results in terms of potential reasons for a lack of participation in computer-supported collaborative learning. Specifically, as this study began, the entire scope of possible reasons for a lack of participation was not known, and therefore open-ended questions provided most of the relevant information. However, now that the key reasons have been identified, a questionnaire could be developed with the potential reasons for a lack of participation in which students selected those that were seen as most relevant to them. This approach could also be taken with potential motivators for increased participation in the VMT Chat program. Students could be presented with a checklist of possible motivators rather than being asked in an open-ended way about what might motivate them to participate in the VMT Chat program. Based on the results of this study, developing such checklists would not be difficult. Of course, such checklists should still be supplemented with open-ended questions so that students could provide relevant information outside those items included in the questionnaire.

Third, as the current study focused on high school students as the primary subject group, to either complete a questionnaire or participate in a one-on-one interview, the quality of the responses was marginal. These students tended to respond “I don’t know” or to give short answers to the questions. Therefore, it is recommended that future research in this area employ data collection procedures that encourage more active participation. For example, focus groups could be conducted with groups of students so that they felt more comfortable relating their experiences and opinions.

Summary

While computer-supported collaborative learning has many proponents (e.g., Bielaczyc & Collins, 1999; Brown & Campione, 1992; Kay, 2004; Kimber, Hitendra, & Richards, 2002), the promise of these programs has not been realized (Astleitner, 2002;

McLoughlin & Luca, 2002), with substantial student resistance to participation (Halloran, Rogers, & Scaife, 2002). This problem has been experienced by The Math Forum's VMT Chat program. The current study contributes to the knowledge of online learning and collaboration by determining why participants are resistant to registering and participating in the VMT Chat service.

The Math Forum aims to provide resources, activities, person-to-person interactions, educational services and products to support teaching and learning. The Geometry Forum was founded in 1992 at Swarthmore College and expanded to become The Math Forum in 1996. The forum's development was funded by the National Science Foundation, and it became part of Drexel University curriculum in 2001, where it began operation within Drexel's School of Education in 2004. The Math Forum has integrated distance learning technology into formal education and is considered a very successful application of the internet to education (The Math Forum, 2005). In its current form, the VMT Chat program is an online collaborative problem-solving exercise in which students work together to solve mathematics problems over the Internet.

The problem investigated in this study is why students show resistance to using the VMT Chat service. Furthermore, this study aimed to determine what factors, if any, will help motivate students to register and participate in this program, and if the motivating factors are effective after implementation. A qualitative methodology was selected for this study as the most appropriate design. Specifically, a case study methodology was employed to document what has taken place from the February 2003 inception of the VMT Chat program through 2006 and to examine the efficacy of implementing two potentially motivating factors: teacher encouragement and the offer of extra credit for participation.

The population in this study is high school students who have participated in the Problems of the Week program offered by The Math Formum or the VMT Chat program. The selection of participants included a broad range of high school students with different levels of computer expertise and mathematical abilities to warrant generalizations about this population. The researcher-developed questionnaire for this study is based on a review of the relevant literature, interviews with experts on computer-based distance education, collaboration, adoption of technology, and employees of the The Math Forum at Drexel University. The questionnaire included both the closed-ended (multiple-choice) items. A total of 227 individuals completed the online questionnaire, but 96 did not indicate that they were in grades 8 through 11, and were therefore excluded from the sample. Participants ranged in age from 12 to 16 years old, and most were female. Interviews with ten students who participated in VMT Chat were conducted regarding their experiences with the service. Of these, three were female and seven were male and they ranged in age from 12 to 15 years. In addition to the online questionnaire and interview data, VMT Chat program meeting notes and the logs of the chat sessions were examined in the hopes that they could add to the findings from the main study data.

The goal of the current study was to examine The Math Forum's online computer-supported collaborative learning system VMT Chat, to address the reasons for low participation rates, to develop an understanding of potential motivators for increased participation, and to implement these motivators to determine if they are effective. Four reasons for a lack of participation in the VMT Chat program were found: a lack of teacher encouragement, a lack of integration of the VMT Chat program in math classes, a potentially confusing and difficult to use computer environment for the VMT Chat program, and a lack of available information, advertising, and marketing for the program. In terms of the changes that would motivate students to participate, it was determined that teacher encouragement and the offer of extra credit were key potential motivators. Finally, implementing these two motivators resulted in participation rate of 56.3% among students who had never used the VMT Chat program in the past. Thus, with careful analysis of the reasons for a lack of participation and potential motivators for participation, it is clear the programs such as VMT Chat can be successful.

The generalizability of the current findings is somewhat limited. Specifically, there is a wide variety of computer-supported collaborative learning programs in existence, and the results of the current study may not generalize to those that are dissimilar from the VMT Chat program provided by The Math Forum. It is likely that the results of the current study will apply primarily to math-oriented computer-supported collaborative learning programs and less so to such programs in different academic areas. In addition, the results of this study may not generalize to students in grade levels other than high school. Math-oriented computer-supported collaborative learning programs in grade schools and/or college may have low participation rates for reasons other than those identified for VMT Chat, and different motivators may be more successful in increasing participation among these groups.

Appendix A

General Student Questionnaire

vmt_questionnaire

Instructions

The Virtual Math Team (VMT) project at the Math Forum will offer you the opportunity to interact with students from diverse schools, classrooms and countries!

By using our special Internet chat and shared whiteboard software, you and your friends will be able to discuss our Algebra and Geometry problems, do your own homework problems together, or talk about any other math topic.

By answering this questionnaire you will help the Math Forum develop the best tools possible for this service and help make your experience a positive one.

Please answer the following questions.

Demographics

1. What is your current age?

(Select only one.)

- ☐ 12
- ☐ 13
- ☐ 14
- ☐ 15
- ☐ 16
- ☐ 17
- ☐ 18
- ☐ Other

2. Are you male or female?

(Select only one.)

- ☐ Male
- ☐ Female

3. What grade are you in?

(Select only one.)

- ☐ 8th Grade
- ☐ 9th Grade
- ☐ 10th Grade
- ☐ 11th Grade
- ☐ Other

Computer Skills

4. You would rate your computer skills as:

(Select only one.)
- ☐ Novice
- ☐ Intermediate
- ☐ Advanced

5. Do you enjoy playing computer and/or electronic games?

(Select only one.)
- ☐ Yes
- ☐ No

6. Do you enjoy playing computer and/or electronic games with others?

(Select only one.)
- ☐ Yes
- ☐ No

7. Do you like having a friend around when you play computer and/or electronic games to get through the hard parts?

(Select only one.)
- ☐ Yes
- ☐ No

8. How often do you play computer and/or electronic games per week?

(Select only one.)
- ☐ 1-7 hours
- ☐ 7-14 hours
- ☐ More than 14 hours

9. Do you access the computer from home or school?

(Select only one.)
- ☐ Home
- ☐ School
- ☐ Both home and school
- ☐ Don't have access
- ☐ Other

10. Are you familiar with web browsers such as Internet Explorer?

(Select only one.)
- ☐ Yes
- ☐ No

11. Have you ever used a web browser?

(Select only one.)

- ☐ Yes
- ☐ No
- ☐ Don't know

12. Have you ever used AOL Instant Messenger or any other instant messenger to communicate with friends?

(Select only one.)

- ☐ Yes
- ☐ No

Collaboration Skills

13. When you chat online to friends, are you a talker or a listener?

(Select only one.)

- ☐ Talker
- ☐ Listener
- ☐ Both
- ☐ I don't chat online.

14. Do you enjoy working in groups?

(Select only one.)

- ☐ Yes
- ☐ No
- ☐ Sometimes

15. Would you rather work in a group setting that is face-to-face or work in a group setting online?

(Select only one.)

- ☐ Face-to-Face
- ☐ Online
- ☐ Either
- ☐ Neither

16. Do you prefer working on math problems alone or in a group?

(Select only one.)

- ☐ Alone
- ☐ Group
- ☐ Doesn't Matter

17. From whom do you prefer to get assistance while trying to solve a math problem?

(Select only one.)

- ☐ Teacher
- ☐ Friends
- ☐ Parents/Guardians

- ☐ Other:

Math Skills

18. Do you do well in math?

(Select only one.)
- ☐ Yes
- ☐ No
- ☐ Other:

19. Do you like math?

(Select only one.)
- ☐ Yes
- ☐ No

20. Are you in an accelerated math class?

(Select only one.)
- ☐ Yes
- ☐ No

Solving Math problems online using PoW and/or Virtual Math Teams

21. Would you rather work to solve a math problem online or in a classroom?

(Select only one.)
- ☐ Online
- ☐ Classroom
- ☐ Either
- ☐ Other:

22. Have you participated in the Problems of the Week?

(Select only one.)
- ☐ Yes
- ☐ No

23. If you participated in the Problems of the Week, were you instructed by your teacher to participate in them?

(Select only one.)
- ☐ Yes
- ☐ No
- ☐ I have never participated in Problems of the Week.

24. The Virtual Math Team service is an online group problem-solving approach to mathematics. The intention of this program is to get students to work together online to solve mathematics problems. Have you used the Virtual Math Team service?

(Select only one.)

- ☐ Yes
- ☐ No

25. What would motivate you to use the Virtual Math Team service to collaborate and solve math problems online?

(Provide one response only.)

26. If you haven't used the Virtual Math Team service would you be interested in using this service?

(Select only one.)

- ☐ Yes
- ☐ No
- ☐ Don't know

27. If you have used the Virtual Math Team Service would you use it again?

(Select only one.)

- ☐ Yes
- ☐ No
- ☐ Don't know
- ☐ I have not participated in the Virtual Math Teams.

28. Did your teacher instruct you to use the Virtual Math Team service?

(Select only one.)

- ☐ Yes
- ☐ No
- ☐ I have not participated in the Virtual Math Teams.

29. When using the Virtual Math Team service, did you find yourself actively responding or did you hold back and let others do most of the responding?

(Select only one.)

- ☐ I actively respond.
- ☐ I let others do the responding.
- ☐ I have not participated in the Virtual Math Teams.
- ☐ Other:

30. Was the Virtual Math Team service:

(Select all that apply.)

- ☐ Fun
- ☐ Easy to use
- ☐ Difficult to use
- ☐ None of the above
- ☐ I have not participated in the Virtual Math Teams.

31. Do you think you will use Virtual Math Team service again?

(Select only one.)

- ☐ Yes
- ☐ No
- ☐ I have not participated in the Virtual Math Teams.

32. Which do you prefer, Problems of the Week or Virtual Math Team service?

(Select only one.)

- ☐ Problems of the Week
- ☐ VMT Service
- ☐ Both
- ☐ Don't know.

33. Do you think the Virtual Math Team service could help you in math class?

(Select only one.)

- ☐ Yes
- ☐ No
- ☐ Don't know

34. Why do you prefer PoW or the VMT Service or both?

(Select all that apply.)

- ☐ Have not used either.
- ☐ Why:

Appendix B

Student Interview Questions for VMT Chat Participants

Student Interview Questions
Age: _________
Gender: Male / Female
Grade: _________

Introduction:

Hello, my name is Ilene Goldman and I will be interviewing you on your experience using the VMT Chat. This interview is for research purposes only. Please don't reveal your name, school or address to me since this interview will remain anonymous.

Please let me know if I may continue with the interview.

1. How do you feel about Math?

2. Are you in an accelerated Math class?

3. What math classes have you had?

4. What areas of math do you feel like you really know?

5. Are you good in other subjects? Which ones?

6. Do you feel like you take leadership positions in classes in your school? If yes, How?

7. Do you ask a lot of questions? Lead small groups?

8. What online services or resources do you most often use for learning? Which do you like most and why?

9. Was this your first VMT Chat session?

10. In this chat did you work at home or in school? If in school were you in a lab with other people?

11. Was it difficult to arrange a common time to participate in the Chat?

12. Were you instructed to participate in the VMT Chat?

13. Please describe the reasons you decided to try out the VMT Chat program if not instructed to do so.

14. Please describe your experience with the VMT Chat.

15. What did you expect the chat to be like? Is that different than what you would like it to be or what you imagine it could be?

16. Please describe how you think this service can help you with your math classes.

17. Did the other students in the VMT Chat help you to solve the problem?

18. What ideas do you have for improving the VMT Chat program?

19. Have you heard of the PoW service?

20. If you prefer the PoW program to VMT Chat, please describe how PoW works better for you.

21. If you prefer the VMT Chat program to PoW, please describe how VMT Chat works better for you.

Appendix C

Advertisement on Drexel University's The Math Forum Web site

The Math Forum @ Drexel

DONATE

Fill out a questionnaire on group problem-solving.

Thanks for submitting your question to Ask Dr. Math!

While you're waiting for your question to be answered, please consider the following:

> We can't respond to every question; however, there is a good chance that your question has already been answered.
>
> So if you haven't already done so, this might be a good time to check the appropriate section (elementary, middle school, high school, or college) of our Dr. Math Library. If you're not sure how to do that, you can find instructions here.
>
> If you don't receive an answer within a couple of days, consider re-submitting your question.
>
> If you have a comment or question about the way Ask Dr. Math works, you can e-mail the administrators.

Once again, thanks for your question, and we hope you hear from us soon!

Appendix D

Adolescent Consent Form

Adolescent Assent Form

Parent/Guardian Consent for Participation in
Ph.D. Dissertation Project
Nova Southeastern University / Drexel University The Math Forum VMT Chat Study

Funding Source: None.

IRB approval # ___________

Principal investigator(s):
Ilene Litz Goldman, Ph.D. Candidate
Drexel University
3141 Chestnut Street
Philadelphia, PA 19104
(215) 895-6742

Institutional Review Board
Nova Southeastern University
Office of Grants and Contracts
(954) 262-5369

Description of the Study:

The goal of this study is to respond to find out what will motivate users from working alone to try and solve a math problem to solving a math problem while working on it with other students, together online. While the Problem of the Week of The Math forum at Drexel University continues to receive high levels of registration and participation, VMT Chat, The Math Forum's online problem solving chat, is lagging far behind: this project, will seek to give suggestions for improved student participation. Information received by middle to high school level students, will be gathered by having the students fill out an anonymous questionnaire.

Risks /Benefits to the Participant:
There is no risk in participating in this study.

Confidentiality: Information obtained in this study is strictly confidential. In addition, any information that can identify you as a participant will not be recorded or used in any way.

Costs and Payments to the Participant:
There are no costs to you or payments made for participating in this study.

Use of Protected Health Information (PHI):
This study does not require the disclosure of any Protected Health Information.

Participant's Right to Withdraw from the Study:
You have the right to refuse to participate or withdraw at any time. If you choose to

withdraw, your data will not be destroyed and will be retained for the length of the study plus three years.

Initial:_____ Date:_______

Other Considerations:
If significant new information relating to the study becomes available which may relate to your willingness to participate, this information will be provided to you by the investigators.

Voluntary Consent by Participant: Participation in this research project is totally voluntary, and your consent is required before you can participate in the research program. If significant new information related to this study becomes available and this information may affect your willingness to participate in this study, Ilene Litz will alert you immediately.

I have read the preceding consent form, or it has been read to me, and I fully understand the contents of this document and voluntarily give consent to participate. All of my questions concerning the research have been answered. I hereby agree to participate in this research study. If I have any questions in the future about this study they will be answered by Ilene Litz Goldman. A copy of this form has been given to me. This consent ends at the conclusion of this study.

Child's Name: ____

Parent's/Guardian Signature: __________________________ Date: ___________

Witness's Signature: ____________________________ Date: ______________

Appendix E

Parent/Guardian Consent Form

Parent/Guardian Informed Consent

Parent/Guardian Consent for Participation in
Ph.D. Dissertation Project
Nova Southeastern University / Drexel University The Math Forum VMT Chat Study

Funding Source: None.

IRB approval # ___________

Principal investigator(s):
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Drexel University
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(215) 895-6742

Institutional Review Board
Nova Southeastern University
Office of Grants and Contracts
(954) 262-5369

Description of the Study:

The goal of this study is to respond to the determination of what will motivate users from individually-oriented problem solving users to online problem solving collaborators. While the Problem of the Week of The Math forum at Drexel University continues to receive acceptable levels of registration and participation, VMT Chat, The Math Forum's online collaborative problem solving forum, is lagging far behind: this project, will seek to redress the problem with concrete suggestions for improved student reception. Information received by middle to high school level students, will be gathered by having the students fill out an anonymous questionnaire.

Risks /Benefits to the Participant:
There is no risk in participating in this study.

Confidentiality: Information obtained in this study is strictly confidential. In addition, any information that can identify you as a participant will not be recorded or used in any way.

Costs and Payments to the Participant:
There are no costs to you or payments made for participating in this study.

Use of Protected Health Information (PHI):
This study does not require the disclosure of any Protected Health Information.

Participant's Right to Withdraw from the Study:
You have the right to refuse for your child to participate or withdraw your child at any

time. If you choose to withdraw your child, your child's data will not be destroyed and will be retained for the length of the study plus three years.

Other Considerations:
If significant new information relating to the study becomes available which may relate to your willingness to have your child continue to participate, this information will be provided to you by the investigators.

Voluntary Consent by Participant: Participation in this research project is totally voluntary, and your consent is required before you can participate in the research program. If significant new information related to this study becomes available and this information may affect your willingness to participate in this study, Ilene Litz Goldman will alert you immediately.

I have read the preceding consent form, or it has been read to me, and I fully understand the contents of this document and voluntarily give consent for my child to participate. All of my questions concerning the research have been answered. I hereby agree to have my child participate in this research study. If I have any questions in the future about this study they will be answered by Ilene Litz. A copy of this form has been given to me. This consent ends at the conclusion of this study.

Child's Name: ____

Parent's/Guardian Signature: ____________________________ Date:____________

Witness's Signature: ______________________________ Date: ________________

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