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A WEB-BASED TECHNOLOGY FOR FOSTERING INITIATIVE

By

Su C. Jones

A DISSERTATION

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ABSTRACT

A WEB-BASED TECHNOLOGY FOR FOSTERING INITIATIVE

By

Su C. Jones

Educators have been interested in promoting student agency in the classroom and in encouraging students to take more action in their own learning. This research addresses this issue by examining student initiative and focusing on how to foster this kind of learning in the classroom. In this investigation, I developed The Mathematics Chronicles (TMC) based on design principles for promoting initiative--public audience, collaboration, and norms and practices. Final interviews with students, observations of student interactions in TMC publishing and non-publishing classroom contexts, and samples of student work from TMC and other classroom assignments were analyzed. Results indicate that how students take initiative vary across publishing and non-publishing contexts. In addition, collaboration, norms, and practices in TMC environment were salient themes emerging from the data as significant in fostering student initiative. Students' perception of an audience, however, was the most powerful aspect of TMC environment that led students to take action, make an effort, and demonstrate volition in their learning.

For my loved ones, Mom, Dad, and Danny

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INTRODUCTION

It was a mathematics classroom at Gayle Middle School, a Midwestern urban setting. Sixth graders sat in groups, as Mr. Watkins (pseudonyms have been used for all participants and the school) had decided, to allow for more collaboration on activities. For some, this was an incentive to participate in their mathematics learning and make efforts to engage in small and whole group discussion. There were days, however, when Mr. Watkins wondered when students would take more responsibility for their learning and demonstrate some initiative. At times, students glanced away hoping the teacher would not call on them to explain their solution strategies because they failed to complete their assignment the night before. On other occasions, Mr. Watkins left the day with disappointment because only one student offered her explanations without any objections or alternative ideas from other classmates. He looked forward to the instances when students would determine their assignments, develop different ways of thinking about mathematics, and challenge peers' arguments. Although some students provided their own different justifications, Mr. Watkins expected more from his learners. "My goal is to have the students rely on themselves instead of always coming to me for how to solve a problem," remarked Mr. Watkins. Indeed, as an observer in this classroom, I noticed events when students took on a role in their own and others' learning as well as moments when they did not seem to realize that learning is held to be an active process rather than a passive one.

This issue of how students might be more active in their learning and how it could be supported is not unique to this classroom, but is a salient theme in the broader educational community. In this study, I ventured to address this problem of student

initiative in learning and how technology can be a medium for fostering initiative by trying to understand how students take initiative and what factors might support it. I developed a Web-based collaborative journal according to design principles for fostering initiative as a context for understanding initiative, but also examined students' work and interactions in activities outside of this technology as a comparison and broader exploration of the issue. The Web-based journal and activities outside of this journal were anchored by the *Connected Mathematics Curriculum* (CMP) (Lappan, Fey, Fitzgerald, Friel, & Phillips, 1996a), an innovative mathematics curriculum especially designed to encourage students' development of connecting mathematical ideas and thinking about mathematics in different ways. Participants were from a middle-school mathematics classroom and took part in this study for most of the school year.

In Chapter 1, I define initiative and review previous research literature on issues related to student initiative. I also present the design principles that led to the development of a Web-based collaborative journal, The Mathematics Chronicles (TMC), to provide an understanding of the underlying assumptions of the development of the environment. Finally, I introduce specific research questions for the study.

Chapter 2, the method of this study, includes discussion of the technology, the context and participants, and data sources. A short description of TMC and explanation of how the design principles were interpreted in the development of this technology is given, as well as a justification for why this technology was built on the Web. Following a more detailed look at TMC and the classroom participating in this study is an explication of how TMC was introduced and how students generally participated in writing in TMC. A description of regular classroom activities is also given to illustrate

students' typical mathematical experience outside of TMC activities. Data sources are then provided.

Chapters 3 through 5 examine the data. The fourth chapter reviews final interviews conducted with students. The fifth chapter targets student interactions in and out of TMC environment, and the sixth chapter reveals a comparison of students' work on TMC and work in their own journals. Whereas the fourth chapter illuminates what factors may foster student initiative in TMC environment, the fifth and sixth chapters illustrate how students took initiative.

Chapter 6 highlights themes across the interviews, observations, and journal work. Data from these sources complement each other to produce a spectrum of themes that provide an overall picture of the initiative occurring in this research and factors promoting the initiative. In Chapter 7, I examine the implications and limitations of this study, and I make my conclusions in Chapter 8.

CHAPTER 1

UNDERSTANDING INITIATIVE

In traditional mathematics schooling, there is an assumption that students should acquire a body of knowledge from an authority such as the teacher (Schoenfeld, 1989). Studies indicate, however, that people often do not use and learn mathematics in the standard forms traditionally taught in school. Rather, learners may develop different ways of thinking and using mathematics in out-of-school contexts (e.g., Millroy, 1992; Nunes, Carraher, & Schliemann, 1993; Resnick, 1987). In recognizing this discontinuity, reform efforts have emphasized the importance of teaching our students so that, instead of "learning mathematics as accumulating facts and procedures," (NCTM, 1991, p. 2), they can construct their own meanings through examining, representing, transforming, solving, applying, proving, and communicating (National Research Council, 1989). Implicit in this goal is that educators and researchers should foster learners who take more agency in their learning of mathematics. The agenda, then, is not simply to teach students bodies of knowledge, but to prepare them to approach new mathematical situations by formulating their own ways of thinking and solving problems.

Encouraging Student Agency

Researchers have been studying the broad issue of how to encourage students to take more agency in their learning from a multitude of angles. Some researchers and educators have been investigating innovative instruction that may support students in developing their own ways of thinking about mathematics. In contrast to teaching students a preconceived set of mathematical representations (Nesher, 1989), Ball (1992)

demonstrates how students and teachers can jointly construct mathematical representations. In this kind of setting, students take a more central role in their own learning by contributing their ways of thinking about mathematical ideas. Also moving away from a traditional classroom where students rely on an authority rather than themselves for mathematical reasoning, Lampert (1987) brings the students' ideas to the fore to "sanction students' intuitive use of mathematical principles as legitimate" (p. 339). Lampert argues that highlighting students' thinking supports students in deciding for themselves whether something is mathematically reasonable. Likewise, Schoenfeld (1989) illustrates how he deflects the teacher's authority by asking students what *they* think and "developing in the class the critical sense of mathematical argument that leads it, as a community, to accept or reject on appropriate mathematical grounds the proposals made by class members" (p. 362).

Cobb, Yackel, and Wood (1992) also address the concern of how students actively learn, emphasizing the role of socio-mathematical norms in encouraging students to work cooperatively in mathematical meaning-making. In these classroom communities, students are acculturated to the norms of formulating different mathematical arguments and justifications. Indeed, research results suggest that students from these experimental classrooms are more intellectually autonomous (Yackel, Cobb, & Wood, 1991) and tend to believe that it is more important to "find their own or different ways to solve problems, rather than conforming to the method shown by the teacher" (Wood & Sellers, 1996, p. 351). Instead of turning to the teacher as the source of mathematical knowledge, students are expected to take a more central role in the development of their knowledge by generating their own arguments and explanations.

The Role of Educational Technology

In addition to developing instructional methods, researchers have used new technologies as tools for promoting students' agency in their learning.

> Success in cognitive functions such as reasoning, remembering, and perceiving is understood as an achievement of a system, with contributions of the individuals who participate, along with tools and artifacts. (Greeno et al., 1996, p. 20)

Along similar lines, researchers have developed technology to represent (Pea, 1993) and augment students' own thinking. In this sense, technology is used to support students' role in the system.

The Geometric Supposer (Schwartz, 1993) is a visual software package designed to enable students to take a significant role in their knowledge development. Instead of presenting a problem for the student to solve, an underlying assumption of *The Geometric Supposer* is that the learner will create her own mathematical problems through formulating conjectures. By proving and generalizing these conjectures from specific cases, the learner generates new understandings (Schwartz, 1993).

Whereas *The Geometric Supposer* enables students to take more agency in their learning by supporting students' development of their own problems to explore, *The Jasper Series*, a collection of interactive laserdiscs, presents mathematical problems embedded in complex, realistic settings (The Cognition and Technology Group at Vanderbilt [CTGV], 1991, 1992). Technology in this setting is used as a rich medium for conveying information and posing problems for the students. A central principle of this series, however, is that students should synthesize the appropriate information from the laserdiscs or other resources to formulate their own solutions. In this sense, *The Jasper*

Series continues to promote researchers' goals of supporting students' generation of their own solution methods.

Whereas *The Jasper Series* has been designed as a source of information students can search and review in problem solving, the Kids as Global Scientists Project (Songer, 1996) illustrates how students use the Internet, as a resource to research and explain meteorological problems and topics that students themselves generated. In this setting, the teacher's role as the sole knowledge resource is diminished as students assume greater responsibility by pursuing their own inquiries using the Internet as a resource (Songer, 1996). Songer's study illuminates how students take agency in their learning, as they become experts who collaborate with other learners from remote sites.

Prior to Songer's work, Brown (1992) proposed collaborative learning that also capitalized on *distributed expertise* in intentional learning environments where students are encouraged to "engage in self-reflective learning and critical inquiry" (p. 149). "In this kind of community, each learner has 'ownership' of certain forms of expertise but no one has it all. Responsible members of the community share the expertise they have or take responsibility for finding out about needed knowledge" (Brown et al., 1993, p. 199). As in Songer's (1996) study, students became experts on various topics as they used the computer to communicate and share their knowledge. However, students in Brown et al.'s (1993) communities of learners developed collaborative software that organized their knowledge as a hierarchical system of topics, themes, and list of resources. As in Songer's study, the computer enabled students to communicate, but here was specifically used as a tool for intentional reflection, learning, and collaboration (Brown et al., 1993) that resulted in a tangible product reflecting students' knowledge development. Despite

the differences between Songer's and Brown et al.'s specific goals, both researchers were promoting the students' role in their own learning.

Scardamalia and Bereiter (1994) have also explored ways to foster *intentional* learners with the development of computer-supported intentional learning environments (CSILE). In this context, learning is the primary goal rather than solely an incidental outcome of students' activities (Bereiter & Scardamalia, 1989). Students pose their own questions and collaborate in the development of knowledge surrounding these questions. A primary goal of this environment is to support students' intentional learning by requiring them, instead of the teacher or a computer, to carry out the diagnostic and decision processes when encountering problems (Scardamalia & Bereiter, 1994). Central to this idea of intentional learning is that students take more agency by not only being able to ask questions in the classroom, but by "growing into a question-asking role" (Scardamalia & Bereiter, 1991, p. 51).

Just as CSILE affords students' choices in learning by allowing them to pose the questions to pursue, TELE-Web, a Web-based literacy environment I have been collaborating with others to develop, supports students in making decisions in their reading and writing activities (Jones, Ferdig, & Zhao, 1998; Zhao, Englert, Jones, Chen, & Ferdig, 1998). TELE-Web is a complex, interactive collaborative environment designed to support students' learning to read and write through a variety of activities. Unlike other technologies that promote students' agency in their learning, TELE-Web is a dynamic web environment especially designed to delegate more responsibility to students by allowing them to choose their audience, individualize their exercises, use or ignore prompts, and create their own topics for discussion. Capitalizing on recently

developed Web-based technology, TELE-Web is another innovation that represents the creativity and exploration of researchers who are striving towards developing a community of learners.

In sum, an enduring theme in education has been how to promote student agency in learning. In addressing this issue, researchers have suggested instructional and technological solutions, but vary in the role they envision for students. Researchers have presented numerous ways that students can participate in their learning to enhance their agency:[1]

- jointly constructing mathematical representations (Ball, 1992),
- relying on themselves for reasonability of their mathematical thinking (Lampert, 1987; Schoenfeld, 1989),
- formulating their own mathematical arguments and explanations, (Cobb et al., 1992; Wood & Sellers, 1996),
- generating their own solutions for solving problems, rather than conforming to the teachers' methods (CGTV, 1991),
- becoming experts who have gained "ownership" of their knowledge through researching resources and collaboration (Brown et al., 1993; Songer, 1996),
- constructing and pursuing their own and other students' questions versus those asked by the teacher or another authority (Scardamalia & Bereiter, 1994), and
- taking more responsibility in their learning by choosing audience, individualizing exercises, using prompts, and creating their own topics (Jones, 1997a)

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[1]These points are not mutually exclusive; references indicate ideas emphasized in particular writings.

Although substantial research has examined instruction and technology that can support students' agency in their learning, this issue continues to be a prevalent theme in education. Previous research I have conducted suggests that students, at times, generate their own ways of completing mathematical activities, but reveals that students still have difficulty with relying on themselves in approaching and making sense of mathematical problems. In one study (Jones, 1998), I examined student-teacher and student-student interactions in a 6th-grade mathematics classroom to investigate what the kinds of interactions that seemed to lead students to take more responsibility for their learning. Results of this work indicate that teachers' questioning created a social expectation for students to rely on themselves to generate mathematical ideas or make process decisions.

Focusing on Student Initiative in Learning

Encouraging students to take agency in their learning is a common thread running through much research, but various researchers hold forth different conceptualizations of the kind of learner they are promoting:

- learners who can *rely on themselves in making sense* of mathematical problems (Lampert, 1987; Schoenfeld, 1989),
- *intellectually autonomous learners* - students who are self-governing (Kamii, 1994) and think for themselves in mathematical knowledge development (Cobb et al., 1992; Wood & Sellers,1996; Yackel et al., 1991),
- *problem-posers who generate their own conjectures* to pursue (Schwartz, 1993),
- *learners who can solve complex mathematical problems* (CTGV, 1992),

- *learners who develop their expertise through collaboration* with other learners *and use Internet resources* to conduct investigations of genuine questions, rather than using the teacher as the primary knowledge source (Songer, 1996), and

- *intentional learners* whose goal is to learn (Brown et al., 1993; Scardamalia & Bereiter, 1994).

My research presents another perspective, *students taking initiative in their learning*, which continues the examination of the broader issue of how to enhance students' agency. I chose the term *initiative* because it connotes ownership, volition, agency, and action on the part of the student. Previous researchers have focused much of their attention on particular kinds of interactions in mathematics learning. My research builds upon and extends this work because initiative encompasses all of these kinds of interactions, and emphasizes students' action in their learning.

Not the same as agency in learning, initiative is one way that a learner's agency is promoted. For example, students' agency in learning mathematics with *The Jasper Series* is supported because they are encouraged to generate their own solutions, rather than being given a solution method to follow. One student may take initiative by experimenting with different solution methods, whereas another student may wait for his partner to find the right strategies and then ask him what his solution is for the problem. Both students are given opportunities for agency in their learning, but how they act upon this opportunity determines whether they are indeed taking initiative.

In addition, student initiative emphasizes different aspects of a student's learning than those studied by other researchers. Cobb et al. (1992) and Yackel et al. (1991) stress the importance of developing intellectually autonomous learners who take responsibility for their learning. In their work, they foreground the issue of learners' development of

arguments and explanations and construction of taken-as-shared meanings. I suggest that students in these settings were encouraged to take initiative in mathematical sense-making and problem solving. My examination, however, also highlights students' initiative in other domains of mathematics learning - making decisions about what resources to use and what procedures to follow in completing a task. Although Cobb et al. (1992) and Yackel et al. (1991) may also support initiative in these domains, I foreground them to broaden the definition of student initiative and of mathematics learning.

Student initiative in learning includes attempting to make sense of mathematical problems (Lampert, 1987; Schoenfeld, 1989), but is not necessarily intentional in the sense of the student explicitly holding *learning* as their primary goal (Brown et al., 1993; Scardamalia & Bereiter, 1994). Intention to learn may be an incidental outcome, rather than a conscious goal for a person taking initiative in her learning. The student's principal objective may not be to learn, but to simply present her own ideas. Initiative is better characterized by a learner's volition in mathematical thinking and decision-making in an activity that may not necessarily include learning as the explicit goal. Rather than simply accepting the knowledge transmitted by the teacher or waiting for the teacher's decision about the one right answer or way to complete a problem, students taking initiative in their learning, as I have defined it, are also making decisions and acting upon them. This perspective, illustrated by students who *make an effort* or *willfully act*, is the focus of this research. Although students asking for the teacher's help in solving problems or completing a task may be taking agency in their learning or intending to

learn, initiative is justified as taking a step beyond first turning to the teacher for direction.

Student initiative can appear in various domains of mathematics learning. I suggest it can be demonstrated in:

- mathematical sense-making,
- participating in group processes, and
- management tasks

Student initiative in learning does not include:

- waiting for the teacher or peer for prompts to complete an activity, or
- asking the teacher for the one way to approach or solve a mathematical problem

Although technology may afford different kinds of learning, little exploration of how to design technologies to support student initiative in mathematics learning has taken place. My research agenda extends this line of inquiry. Like Brown (1992), I "attempt to engineer" an innovative technology designed to support student initiative and at the same time study this tool. I also examine the salient factors of this environment that may or may not foster initiative in mathematics learning to understand how technology may be designed to support and enhance these kinds of interactions.

Engineering a Technology to Augment Student Initiative

Engineering an environment that fosters initiative in the classroom requires thoughtful consideration of a sundry of theoretical premises. I draw from three principles

to design a technology to foster initiative:

1. Researchers have argued that *norms and practices* significantly shape how learners participate in the classroom community (e.g., Ball, 1992; Cobb et al., 1992) as well as in other settings (Lave, 1988; Millroy, 1992; Nunes, Schliemann & Carraher, 1993). Thus, norms and practices of the classroom community that encourage student initiative in learning should be established.

2. Opportunities for students to offer their own thinking arise when they encounter conflicting ideas of other learners (Leikin & Zaslavsky, 1997, Yackel et al., 1991); therefore students should be encouraged to *collaborate.*

3. Students who present their work to a public forum (Lampert, 1987) and to a wider audience than the teacher (Cohen & Riel, 1989) tend to be more explicit and generate their own thinking. As a result, a technology, which affords *publishing to an audience* outside the classroom, as well as the learners in the classroom, should be developed to afford student initiative in elaborating their thinking and ideas.

Norms and Practices of the Community

Participating "in social practices plays a crucial role in all aspects of a student's learning in and out of school" (Greeno, Collins, & Resnick, 1996, p. 20). Brown (1993) attempted to create communities of learners in which students and teachers felt individual responsibility in communal sharing of their knowledge. In these communities, each person was viewed as an expert, and the norms and practices entailed developing one's expertise and sharing of knowledge with other learners. With the support of the teachers' modeling, students assumed roles as experts and were acculturated to the norms and practices of these communities of distributed expertise.

Contrasting with Brown's communities, which were specifically designed to foster cooperation, classrooms in which the norms and practices were inextricably mathematical activities have been engineered (Yackel et al., 1991; Wood & Sellers, 1996). Students in these classrooms were enculturated into developing their own ways of thinking about mathematics, offering peers' help in making sense of their solution methods, and providing arguments and explanations. The teacher did not reward or punish students for failing to participate in these ways of learning. Rather, she guided the establishment of the community practices by initiating a discussion of the expectations during group interactions and of spontaneous cases when students were or were not attuned to the practices. Indeed, students not only indicated the importance of these practices, but also emulated them in cooperative learning environments (Yackel et al., 1991).

Collaboration

Collaboration has been the core framework for innovative instructional practices that afford student initiative in learning in many different settings. Leikin and Zaslavsky (1997) report that students who were collaborating had more opportunities to offer their ideas to help others. Likewise, Yackel et al. (1991) argue that in the collaborative environments fostered in their classrooms,

> opportunities arise naturally for [students] to verbalize their thinking, explain or justify their solutions, and ask for clarifications. Further, attempts to resolve conflicts led to both the opportunity to reconceptualize a problem and thus construct a framework for another solution method, and the opportunity to analyze an erroneous solution method and provide a clarifying explanation. (p. 401)

Collaboration afforded student initiative in these classrooms by providing students appropriate contexts to offer their ideas and feedback. In addition, encounters with peer disagreement encouraged them to reformulate and clarify their thinking. A student who explains his thinking to a partner presenting an erroneous answer must extend his "own conceptualization of the problem to try to infer how the partner might have been trying to make sense of the problem" (Yackel et al., 1991, p. 402). Collaborative work not only allows students to offer their own thinking, but also provides grounds for generating new arguments and explanations. Therefore, collaboration affords student initiative in learning by providing opportunities for students to present and generate their thinking.

More recently, technology has taken a central role in maintaining and extending collaboration in learning environments in which students choose to pursue their own questions or area of expertise. CSILE (Scardamalia & Bereiter, 1994) has been used to support students' collaboration, but has afforded student initiative by enabling students to propose questions to pursue and jointly construct ideas in answering these inquiries. In addition, Brown et al. (1993), Songer (1996), and Jones (1998) have illustrated how the Internet can be used to enable students to collaborate with others in cultivating their learning. Technology in these contexts has augmented students' initiative in learning by allowing students to both choose from a wider audience with more diverse expertise and to contribute their own knowledge.

Publishing to a Public Audience

Publishing to a public audience, the third design principle, enhances initiative in learning in several ways. As discussed, students can publish their work for their own

classmates' reflection and review. However, one potent factor is that the audience potentially extends beyond the classroom. Rather than completing their assignments or doing mathematics only for the teachers' review and approval, students can publish to a wider audience of other children who can learn from the journal, other teachers who can generate ideas about how they can teach, and parents who can understand how students are learning. Publishing to a wider audience may lead students to articulate their ideas better, thus enhance their writing. Cohen and Riel (1989) illustrate that learners writing to a real audience who were interested in more than grading students' work wrote more fluent, better organized compositions with ideas more clearly stated and supported. With the perception that the audience would not have the knowledge base pertaining to their composition topic, students writing to distant audiences seemed to elaborate on their ideas more. Publishing to a public audience, in this sense, affords student initiative in learning because through attempting to clarify ideas, students are more likely to develop and make their thinking explicit as they present their work. Although the students in this study were not necessarily writing on mathematics, its implications may apply to a mathematical context as well.

What Is Initiative and How Is It Supported?

This study investigates student initiative through several strands. First, I develop and study an innovative publishing environment on the Web, The Mathematics Chronicles (TMC), which is based on these principles for fostering student initiative in learning mathematics. I also examine the kinds of initiative students demonstrate in and out of the publishing environment and which activities tend to support these kinds of

initiative. My research questions are:

1. What kinds of initiative does TMC foster?
2. What factors of TMC publishing support initiative?
3. What kinds of initiative do nonpublishing activities support?

CHAPTER 2

METHOD

I have discussed three principles that motivated the design of a technology I developed to study initiative. In this chapter, I begin with a detailed overview of this technology and how illustrates these principles. I continue with a more detailed description of the Mr. Watkins's 6th grade classroom that participated in this work, and how this setting met the needs of this research. Finally, I include the instruction around the technology environment, and data analyzed for this study.

The Mathematics Chronicles, an Interpretation of the Design Principles

The Mathematics Chronicles (TMC), a Web-based interactive publishing environment was designed to foster initiative. TMC serves as a collaborative journal organized to be used in conjunction with the Connected Mathematics Project (CMP) curriculum (Lappan et al., 1996a). The CMP curriculum consists of unit topics divided into investigations focusing on subtopics. This Web-based journal supports students' documentation of their major mathematical ideas and solution strategies in studying the investigations of each unit and is structured to enable students to write entries—main ideas, solution strategies, or reflections—for each of the investigations. TMC is organized in this fashion to align it with the curriculum, but more importantly, to provide a loosely structured and cohesive journal for easy navigation that allows flexibility in the content students develop. A more detailed overview of TMC will be provided later. First, I discuss how TMC illustrates the three principles: norms and practices of the community, collaboration, and publishing to public audience.

Norms and Practices of the Community

An underlying principle of TMC is that norms and "practices of a community provide facilitating and inhibiting patterns that organize the group's activities and the participation of individuals who are attuned to those regularities" (Greeno et al., 1996, p. 20). The following norms and practices around TMC publishing were promoted to foster student initiative:

1. *Students are the authors.* The Web-based Mathematics Chronicles is a product of the students' collaboration; therefore, the students are viewed as the authors. Since students, rather than the teacher, take the role as the source of knowledge, they take on greater responsibility for generating their own thinking and ways to solve problems. By viewing themselves as the experts who are sharing their knowledge, students are more likely to research the mathematics they would like to present to the audience (Songer, 1996). In this sense, with the understanding that they are the creators of The Chronicles, I expect students to use this opportunity to take initiative in developing The Chronicles.

2. *Students should take the initiative.* The Mathematics Chronicles should represent the diversity of students' own mathematical learning; therefore, they are expected to take the initiative in generating arguments, explanations, solution strategies, and questions they would like to pursue, as well as deciding how to complete and publish their work. Because the typical school rewards of grades is not given for publishing on The Chronicles, students' initiative in the development of their materials for publication should not reflect students' goal to attain a grade. Yackel et al. (1991) illustrates how making expectations for classroom norms explicit can shape how students learn in the

classroom. Likewise, I suggest that presenting the expectations for student initiative supports students in beginning to emulate this kind of learning.

3. *Students need to collaborate.* Students are expected to collaborate with peers in developing and refining questions, arguments, explanations, reflections, and solution strategies that they would like to publish to The Web-based Mathematics Chronicle and in making decisions as they complete their work. In collaborative settings, students tend to offer their own thinking (Leikin & Zaslavsky, 1997; Yackel et al., 1991), and in this sense, may enhance student initiative. I will detail the benefits of collaboration as I explain its importance in the design of The Web-based Mathematics Chronicles below.

4. *Students should use strategies for promoting collaboration and student initiative.* As advisors and authors, students are given the following questions to keep in mind:

- Is the work an example of the main idea of the investigation?
- Is there evidence for what is being argued?
- Can the work be changed to make it clearer?
- Are there other ways to explain what is being argued?
- Are there other suggestions for providing better evidence?

Collaboration and student initiative are supported through providing students with questions that give them a sense of the kind of initiative in learning that is promoted in the classroom.

5. *TMC should represent diverse authorship.* Students are asked and encouraged to volunteer to publish their work. TMC is presented as a shared product that should illustrate the diverse and valued knowledge of all the students.

6. *Students should think about their audience when writing for TMC.* Some people may be reading the journal because they are interested in what the students are

learning (e.g., parents, teachers). Other readers may also learn from their work (e.g., students in and outside the class, teachers). Cohen and Riel's (1989) study suggests that students who believed that their audience did not have an understanding of their work tended to write more highly rated papers that were more explicit and detailed than those written for only the teacher. With the perception of a diverse audience who may or may not already have a prior knowledge about the students' work, students are expected to take more initiative in clarifying their thinking and seeking resources that will support the development of their publication.

Collaboration

Another important design principle of TMC is collaboration. Students are expected to collaborate in pairs when developing work for the Web-based journal. As advisors who encourage and support other learners, students can assist each other in developing entries of an investigation for publication. Because students are expected to negotiate their mathematical sense-making through collaboration, their initiative in learning is fostered as they are given the opportunity to generate their thinking and offer their suggestions to partners (Cobb, Wood, & Yackel, 1990).

TMC also promotes student initiative as a collaborative tool, a common space for learning. On one level, students may use their own work or those of their partners to initiate discussion of mathematical ideas or questions. On another level, however, TMC can be used as a record or artifact of all students' learning to reflect upon in formulating thinking. As a public space for discussion, students can review other learners' work to question, build upon, or seed their own learning (Brown, 1993). Initiative in thinking may take the form of annotations to other students' published work, offering of ideas

related to examples from the journal during whole class discussion, or providing suggestions during one-to-one interactions with an author. In this respect, TMC is both a means for and an object of discussion.

Publishing to a Public Audience

Presenting a mathematical journal to a public audience can also support students' initiative. I argue that in this Web-based publishing environment, students can take more initiative as they reformulate their questions and ideas to better "teach" or illustrate to the audience the mathematics they are studying. As important, another benefit of TMC is that it is a publication of the students' thinking. The presentation of the students' work does not only give the learners' thinking more equal weight to the teachers' ideas, but sanctions students' intuitive use of mathematical principles as legitimate in a public forum (Lampert, 1987). Since the students are given authority over how TMC entries is developed and the thinking that they want to make public, they may demonstrate more initiative in deciding what to publish and in the process of developing their publications.

Why the Web?

Publications can take many forms: newspapers, paper portfolios, a CD-ROM of the collection of students' work, and so forth. However, I decided to use a Web-based environment because of the following unique features:

1. *The Web is a multimedia tool.* Unlike a text-based document, The Web-based Mathematics Chronicles allows students to capture images, sounds, and videos to present their work. Because students may have difficulty expressing their ideas solely through text, multimedia options may enable students to communicate their thinking more easily

(CTGV, 1991). Difficulties in reading and writing may create obstacles for some children trying to understand mathematical text. Multimedia, however, may support and extend students' mathematical experiences by enabling them to capture and reify their learning. In addition, students who do not offer their mathematical ideas because of their difficulty with reading or writing may take initiative in presenting their thinking when provided with other ways of expressing themselves.

2. *Publications on the Web are immediately distributed.* Immediate distribution is another important benefit of the Web. Instead of waiting to have their work processed through a printing press for a newspaper or replicated as software to be distributed, students can publish their work instantly. Publications can be posted daily, so the audience can view the students' work on an on-going basis. More importantly, students can receive responses from peers and maintain a conversation about their mathematical work. As with electronic mail, students can read and critique other learners' work in their spare time (i.e., after other class work is completed, during study hall, at home). Ultimately, the goal is that because the Web serves as a publication that can be accessed in and out of class, students can write mathematics entries outside of the regular class period.

3. *The Web allows for a common forum.* As a collaborative product, The Chronicles serves as a common forum for students' presentations. Unlike individual journals, this Web-based publication is a collection of students' ideas and work. With the ability to read and comment on other students' work more immediately than with other publications (e.g., newspapers, CD-ROMs), children can share their ideas with anyone in the classroom. These conversations are documented as a reference, but presented as a

public record, so a child can collaborate with one, two or more students who are not typically working together.

4. *The Web saves time and money.* Publishing work as CD-ROMs, newsletters, or booklets may be less expensive than producing Web sites if a school does not have Internet access or Web space. With Internet access and Web space, however, publishing to the Web saves time because students can immediately post their work instead of through the process of collecting samples, compiling them, and then submitting them for print. If a classroom has already incurred the costs of a computer and Internet access, a Web publication is the least expensive. Moreover, a wider audience can view the work without the further costs that might be incurred in producing CD-ROMs or paper publications.

A Closer Look at The Mathematics Chronicles

The Mathematics Chronicles (TMC) is an interactive Web-based journal that the students create and develop. TMC is organized in parallel with the structure of the CMP curriculum (Lappan et al., 1996a), as units and investigations within those units. Upon entering the site (see Figure 1), the viewer was required to login with a username and password. Students were given login names and chose their own passwords to access the site as authors to ensure security of their own work. Visitors were advised of a username and password to use for viewing student work.

Students (authors) and the viewers (audience outside the classroom) had separate interfaces. After logging in, students could create a new publication or read the journal (see Figure 2). When editing, students needed to determine the unit, investigation, type of entry, content of the publication, and whether to include any annotations (graphics,

sound files, or video clips). Annotations were organized on the school hard drive as well as the Web server. In addition, students could choose to "read it from school." This option allowed them to view work that may have included multimedia with a shorter wait time because these files were on the hard drive they were using at school and allowed them to upload them more quickly. Otherwise, they could view it through the "journal from home" option. Students were then provided a list of two units, Bits and Pieces I and Bits and Pieces II, in addition to the investigations within those units (see Figure 3). Authors were able to click on an investigation that they chose to read that was organized according to type of publication: main idea, solution strategy, reflection (see Figure 4). When reading publications, students click on response and provide the response as in Figure 5.

The audience outside the classroom was not able to edit publications, but could read student work. After logging in, they could choose from the list of units and investigations as in Figure 3. Their interface, shown in Figure 6, enabled these viewers

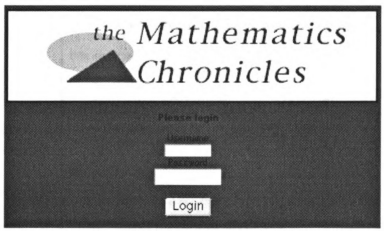


Figure 1. Login page for users to enter the site with a username and password.

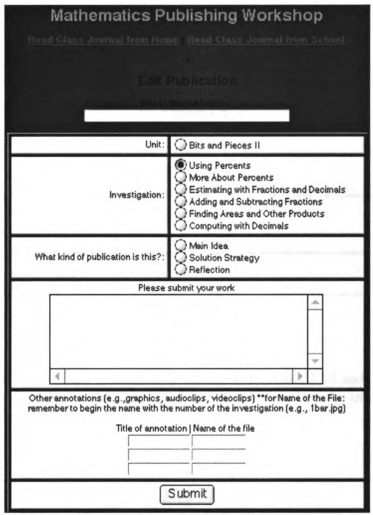


Figure 2. Editing page for students to add entries to The Mathematics Chronicles.

The Mathematics Chronicles

Bits and Pieces I

- Fund-Raising Fractions
- Comparing Fractions
- Cooking with Fractions
- From Fractions to Decimals
- Moving Between Fractions and Decimals
- Out of One Hundred

Bits and Pieces II

- Using Percents
- More About Percents
- Estimating with Fractions and Decimals
- Adding and Subtracting Fractions
- Finding Areas and Other Products
- Computing with Decimals

Figure 3. Outline of The Mathematics Chronicles into units and investigations.

Bits and Pieces I
Comparing Fractions

Main Ideas

Which is larger?
By **Student A**
Date, Time

Compare

Responses

Add a response

Solution Strategies

Benchmarks
By **Student B**
Date, Time

Problem 1 part a- You make a fraction strip labled the fractions 3/12 and 7/12. Then you see what fraction is closer to one then the other. Then you see that the fraction 7/12 is larger.

fraction

Responses

Add a response

Reflections

Benchmarks
By **Student C**
Date, Time

Some numbers are closer to 0 and some are closer to 1. If a fraction is between 0 and 1/2 then it is closer to 0. For example, 3/12. Because 6 is half of 12 and 3 is less than 6. You have 6/12. 6/12 is 1/2. 3/12 is closer to 0 because 3/12 is less than 6/12. It is closer to 0 than a half.

Responses

Add a response

Figure 4. Investigations included main ideas, solution strategies, and reflections.

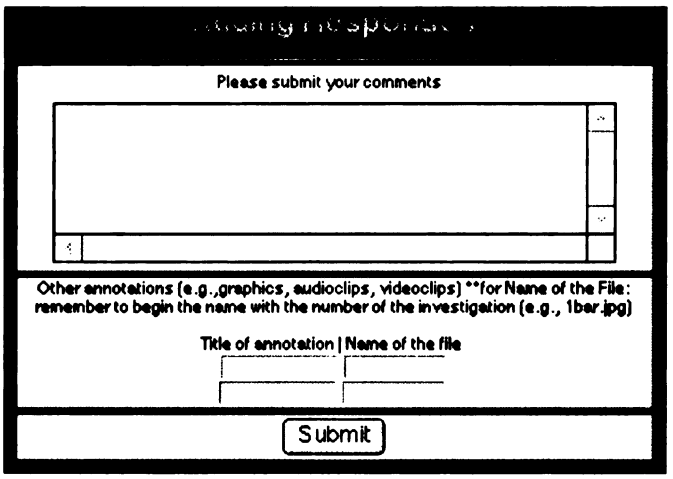


Figure 5. Response page for students to modify or comment on entries.

Bits and Pieces I
Comparing Fractions

Main Ideas

Which is larger?
By **Student A**
Date, Time

Compare

Responses

Would you like to respond?

Solution Strategies

Benchmarks
By **Student B**
Date, Time

Problem 1 part a- You make a fraction strip labled the fractions 3/12 and 7/12. Then you see what fraction is closer to one then the other. Then you see that the fraction 7/12 is larger.

fraction

Responses

Would you like to respond?

Reflections

Benchmarks
By **Student C**
Date, Time

Some numbers are closer to 0 and some are closer to 1. If a fraction is between 0 and 1/2 then it is closer to 0. For example, 3/12. Because 6 is half of 12 and 3 is less than 6. You have 6/12. 6/12 is 1/2. 3/12 is closer to 0 because 3/12 is less than 6/12. It is closer to 0 than a half.

Responses

Would you like to respond?

Figure 6. Interface enables visitors to e-mail comments or feedback to authors.

to read and respond to publications as well through electronic mail. The mail was directed to me so that it could be filtered before presentation to the students.

The Context

Teachers' knowledge and beliefs about learning heavily influences their classroom instruction (Borko & Putnam, 1994). Therefore, a teacher's perception of the importance of student initiative in learning would influence how any proposed instructional method or technology is integrated. If I conducted this study with a teacher who did not support students' initiative in learning, he or she may not have implemented the use of TMC as I had designed it. As a result, I would be unable to attribute a lack of student initiative to the technology or to the teacher's belief that students' initiative in learning was not important. Therefore, it was important to conduct this research with a teacher who wanted to encourage students' initiative in learning. Mr. Watkins had this goal.

This classroom site also had students who took initiative in their learning at times, but continued to struggle with this kind of learning overall. Conducting research in this site allowed me to understand what kinds of interactions were supporting student initiative. Because the students in this classroom were not consistently taking initiative in their learning already, I was able to study the impact of the Web-based publishing environment. In addition, since students were sometimes taking initiative in learning, I could better formulate how the technology and interactions around the technology might be designed to support and enhance student initiative. An alternative would have been to study a classroom in which the teacher was already implementing instructional methods that successfully support initiative. In such a classroom, I might have learned more about

factors I could augment with technology. I might not, however, have found sufficient variance in student initiative between the context of TMC and other activities to be able to gauge the influence of TMC on initiative.

I have been collaborating with Mr. Watkins, a middle-school teacher who was indeed interested in fostering student initiative in learning. He was looking for resources, aids, and teaching techniques that could help him encourage learners to "rely on themselves and their own resources" when encountering mathematical problems instead of depending on the teacher to answer questions (Personal communication, September, 19, 1996). Mr. Watkin's classroom was optimal for my research in many respects. The teacher already valued learning in which students thought and decided for themselves and was very excited about learning and integrating new technology and instruction which would help him encourage student initiative in learning (Personal communication, October, 28, 1997). Informal observations of one of Mr. Watkins's 6^{th}--grade classes and discussions with him confirmed that these students, at times, demonstrated initiative in their learning and at others had difficulty doing so. In this sense, I could study more closely how students took initiative as well as how TMC might foster initiative.

Mr. Watkins's classroom, set in a Midwestern urban school, included 22 students, 17 who consented to participate in this study. Pseudonyms were given for the teacher and students. This classroom had two computers for publishing TMC entries.

Students studied from the CMP curriculum (Lappan et al., 1996a). The CMP curriculum is organized as units and investigations within those units. The units represent domains of mathematics (e.g., fractions and decimals, geometry, probability) and investigations represent particular lessons within those domains (e.g., relationship

between fractions and decimals, determining probability through experiments). The CMP curriculum was designed to foster students' development of connecting mathematical ideas across domains within mathematics. Mathematical concepts are presented through problems in realistic contexts ranging from considering discounts in a store to determining how much of an ingredient to include in a brownie recipe. In contrast to more didactic instruction, the CMP curriculum encourages students to develop their own strategies for addressing problems and emphasizes the importance of diversity in students' thinking. Because the CMP curriculum is supportive of students' development of thinking about mathematics in different ways, it was appropriate for supporting the goals of this study.

Nonpublishing Activities

Class activities outside of TMC environment, nonpublishing activities, included individual, whole group, and small group work. Typical instruction included whole group discussion of an investigation or problems taken from the CMP curriculum, with students presenting their questions, ideas, and strategies. During these whole class activities, Mr. Watkins facilitated discussion on new or studied topics and led examinations of homework or class assigned problems. Students were asked to talk about their ideas and strategies for solving problems and to provide written explanations or drawings on the overhead. These kinds of interactions were encouraged by Mr. Watkins' solicitation of students' ideas and asking students whether they agreed or disagreed with the ideas to highlight their authority in mathematics learning. Students also worked in small groups or individually to complete assignments or review completed work. Each investigation ended with a reflections exercise during which students wrote

general summaries of what they learned from the investigations and a Unit Project which was the culmination of the ideas of the unit.

TMC Environment

Introduction to The Mathematics Chronicles. Mr. Watkins introduced TMC to his students at the beginning of this study by outlining the discussed norms and practices in his own words. The following were the norms and practices Mr. Watkins presented to the class:

1. *Authors are Students.* The Web-based Mathematics Chronicles is a product of your collaboration. YOU are the authors and creators of this journal.

2. *Collaboration.* You are expected to collaborate in small groups on the work that you would like to publish. You will also be acting as advisors to each other.

3. *Student Initiative.* The Chronicles will represent the diversity of your mathematical learning. You WILL NOT receive a grade for publishing. Therefore, you are expected to take the lead in generating arguments, explanations, solution strategies, questions, and deciding how to complete and publish your work.

4. *Strategies for Taking Initiative and Collaboration.* As Advisors and Authors, keep the following questions in mind:

- Is the work an example of the investigation?
- Is there evidence for what you're saying?
- Can you change anything to make it clearer?
- Are there any other ways that you can explain it?
- Are there other suggestions for providing better evidence?

5. *Diverse Authorship.* You will be encouraged to publish your work. The Chronicles is a shared product that should show the variety of thinking that we have here.

6. *Audience analysis.* The Chronicles will reflect all of our various mathematical experiences. Whoever reads this journal might be interested in what you are learning or in learning something new themselves. Keep your audience in mind as you write.

On the first day TMC was presented, a whole-class discussion reviewed these norms and practices to begin establishing the publishing activity. Students were encouraged to contribute their explanations of each practice to involve them in constructing a common understanding of how children can promote each practice during publishing. For example, Mr. Watkins suggested what it meant to collaborate and for students to take initiative in accomplishing their task, but asked for students' ideas on what they, themselves, thought about these norms and practices. This negotiation helped us get a sense of whether students understood the norms and practices but also generated students' thinking about what each practice promotes. These norms and practices were posted in the classroom so students could review it while publishing, and students were also given their own copy of these norms and practices to keep in their notebooks for reference. In addition, I reminded students of these norms and practices when students published on TMC for the first time.

Publishing on The Mathematics Chronicles. Because students requested the opportunity to publish on almost a daily basis, we kept a record of who had published to ensure that all students had the opportunity to publish. Students chose partners to work with while publishing. For the first month of this study, only one group was chosen to publish each day, so I could provide enough support to establish norms and practices around the publishing environment and assist students with technical problems (e.g., typing, logging in). The authors of the day sat at the computer and were also required to

participate and be responsible for material discussed and completed during regular (nonpublishing) class discussion. Beginning the second month of the study, a laptop was also used for students to create publications. Students could publish on TMC throughout the 6 months of this study.

Students were expected to publish work they thought demonstrated what they were learning in the investigations or annotations to their peers' work. They could write text, scan work, and create audio clips or video clips for publication on TMC. Because establishing norms and practices is an on-going activity (Yackel et al., 1991), students were reminded of them when appropriate. For example, if a student asked me what they should publish, students were reminded to ask their partner for help.

Data Sources

My general research goal is to understand how technology can support initiative. To address this issue, I examined what kinds of initiative students take and what factors of contexts support initiative. Data sources included observations of class activities in and outside of TMC environment (audiotapes, videotapes, and field notes), samples of student work, recordings (audiotapes and field notes) of discussions with Mr. Watkins, and final interviews.

Observations included videotapes, audiotapes, field notes, and samples of student work. Students who were observed were given a tape recorder and were asked to keep the recorder with them during class activities (publishing and nonpublishing). The videocamera was focused on as many of the observed students as possible and was used primarily to capture the whole class discussions to set the context for an episode. Samples of student work completed during these activities were also collected to provide a better

understanding of the object of discussion and students' products. Observations of nonpublishing activities included small group, whole group, and individual work.

In the first few weeks of the project, observations of all students within the nonpublishing context were collected. I videotaped and audiotaped 2-6 students a day until all of the students were observed. In addition, videotapes and audiotapes of the introduction to the norms and practices of TMC and students' first experience with TMC were recorded. Since I attended this class on almost a daily basis, these data were collected throughout the 6 months of the study. Data included at least 3 observations of each student participating in both publishing and nonpublishing activities in addition to other data collected incidentally throughout the study. However, data analyzed for this research was taken from end of the year observations of the students in each context because it was at this point that students had experience in both contexts.

Other student work included TMC entries and each student's individual journal entries spanning the course of this project. These data were used to compare how students took initiative in writing in TMC and their individual journals. TMC entries were publications from the Web and individual journal entries were copied from students' spiral-bound notebooks. All 47 TMC entries were analyzed for this work and represented publications made throughout the course of the project. To compare with TMC entries, 44 of students' individual journal were analyzed and were selected to also represent work over the course of the project. To make my selections, I determined the first and last dates of TMC entries and the date that fell in the middle of the entries to represent key dates of the beginning, middle, and end of the project. Selected individual journal entries were those closest to the key dates. On a few occasions, students

discontinued writing in their individual journals before the end of the project, so entries representing end dates were not selected from these journals. Recordings of conversations with Mr. Watkins were used to complement and explain observations and student work. These data were used to understand in what ways students took initiative.

In addition, final interviews with students were conducted at the end of this study. The interviews were used to capture why students may or may not take initiative, particularly in TMC environment. Questions targeted the students' perceptions of TMC and their comparisons of this environment to other mathematics activities (see Appendix A). Topics included:

- how students believed writing on TMC was similar and different from writing in their own journals or in class activities,
- why students would rather publish on TMC or write in their journal,
- why students would rather publish on TMC or participate in other activities,
- how students would describe TMC and its purpose,
- why students found TMC interesting,
- why TMC might support them in doing mathematics more,
- if students read other students' TMC entries,
- if students have written in journals before, and
- if students had published on the Web before this project.

Each student was interviewed separately in another room. Interviews were audiotaped and transcribed for analysis.

CHAPTER 3

FINAL INTERVIEWS

In the following three chapters, I present data for how students took initiative and themes that may explain how initiative was supported in the various contexts. Chapters 5 and 6 reveal how students take initiative in publishing or nonpublishing contexts and in writing in TMC or in their individual journals. I begin with students' final interviews to present emerging themes that allude to why students may take initiative. I then move on to Chapters 5 and 6 to continue with how students took initiative to understand how students' perceptions reflected in their interviews were realized in student interactions in activities and in their written work.

The final interview (Appendix A) was conducted during the last week of the project with 16 of the 17 students. One student was absent during this period. In this chapter, the description of students' responses is structured around the interview as it was generally conducted. The interviews with particular students, however, may have departed from this structure as was appropriate at the time. When students' thinking was not apparent or clear during the interview, I asked prompting questions. At other times, students had already addressed an issue, so I moved on to a different question. In this chapter, I discuss the student responses and highlight themes with specific examples representing these themes. A transcript of each student's responses can be found in Appendix B; a list of students' responses organized by question appears in Appendix C.

The goal of the interview was to reveal:

- how students would describe The Mathematics Chronicles (TMC),
- students' perceptions of its purpose,

- whether and why they prefer the TMC over other mathematics activities, and
- how the Web journal compares with other activities.

Exploration of these issues delves into themes that, in the following chapters, will be compared with and complemented by data from student interactions in and outside of the TMC environment and by a comparison of student work from TMC and individual journals. Here, final interviews provide a window into students' understanding and beliefs about TMC to begin the examination of how TMC may support initiative.

Question 1: Do you think that publishing journals on the web is different from writing in your math journals? How?

Table 1 illustrates the distribution of student responses to Question 1. Overall, the majority of the students (75%) indicated that writing on the TMC was indeed different from writing in their own journal.

Table 1. Distribution of Responses on Writing in The Mathematics Chronicles Versus Individual Journals as Same or Different

	n	%
Different	12	75
Same and different	2	12.5
Same	2	12.5

In addition, students gave several reasons for the difference:

1. The Web journal seemed to be different from individual journals for some students because they perceived an audience. *People besides the author or teacher* could

read students' work because it was on the Web:

> ... when you publish in your journal it's just for you, but when you publish on the Internet, it's for everybody else. [Mandy, final interview]

> ... in the math journal, the only people who see it are you (Jones) and Mr. Watkins, but on the Web, other kids who are having problems or whatever, they can look on our sheet. [Camrn, final interview]

2. Other students enjoyed publishing their journals on the Web more than writing in their own journals. *Students repeatedly expressed that it was "fun":*

> It's more fun because you get to type on the computer, you are on the Internet and put what you want to publish. [Lynton, final interview]

> I think because when you get an experience with typing and working on the computer. It's more fun. You get to learn how to publish things and it's more exciting. We can look at it from home and look over it. It seems better than doing it with paper and pencil. [Justin, final interview]

3. Students also compared the difference in the content of the two kinds of journals. They indicated that in their own journals, they write what they did in class, but *on the Web, provided more detailed explanations of the mathematics they were learning*:

> Yeah, because when you are on the computer, you talk about how you do it and how you get the answer, but in your journal, you write what did you do in class. Like, in class we did 3/4 and 1/5 and we learned how to do times. On the web, it's about the same thing, but you talk to other people and tell them how to do it. [Ande, final interview]

> ... because everybody can read it. You write all the steps and stuff. You tell the solution strategy. In the journal, you just write what you did that day and an example. [Jake, final interview]

The following are the responses that 2 (12.5%) students gave indicating that the TMC was both similar to and different from their individual journals:

> Sort of different because I write more in my journal, but not as long. But it might be the same because I don't write much in my journal, either. [Jeff, final interview]

It's different because. Well, it's the same. I write about like what we did in class, homework assignments in my journal, well, I don't write homework assignments on the web. It's sort of both, same and different. [Kyndi, final interview]

Finally, the following are the responses of the 2 (12.5%) students who suggested that they were basically the same:

No. I like the web better. You don't have to have a pencil, so you can just publish. [Ganton, final interview]

Not really because it is just writing on the computer instead of the paper. [Tinse, final interview]

Question 2: Do you think what you write is different on the web versus what you write in your individual journal? How?

As Table 2 summarizes, for Question 2, 43.75% of the 16 students indicated that the content of their TMC entries was different from that of their own journals, whereas 56.25% indicated they were the same.

Table 2. Distribution of Responses on Same or Difference of Content Between The Mathematics Chronicles Versus Individual Journals

	n	%
Different	7	43.75
Same	9	56.25

The general trend among those who reported a difference in content between the two journals was that students perceived a wider audience on the Web and felt they should *explain it so everybody could understand it*:

Yeah. You go into more detail on the Web. People explain it better so other people can understand it. [Kyndi, final interview]

Indeed, students distinguish how they would write when the readers are other than themselves:

> Sometimes [what I write in my journal is different from the web] because it's more for myself, so you only have to explain it so you understand. [In the web journal,] you have to write it so everybody can understand it. [Jeff, final interview]

Those suggesting that their writing on the Web was not different often simply reported that "No, they aren't different." Some students, however, were more specific, explaining that they wrote strategies, examples, problems, or what they did in class:

> No. I write things like strategies and problems I am doing. [Mandy, final interview]

> A little bit of the same thing because you have to put examples and what you did in class. [Camrn, final interview]

One student suggested that there was no difference between what she wrote on the Web and what she wrote in her own journal "because when I write something in my journal, I usually write that on the web."

Question 3: Would you rather write in your journal or on the web?

For Question 3, Table 3 shows that a majority (87.5%) of the students would rather write on the Web than in their own journals.

Table 3. Distribution of Students' Preference of Writing in Individual Journals or on The Mathematics Chronicles

	n	%
Web	14	87.5
no matter	2	12.5

Students preferred the Web journal because *it enabled learning, teaching the audience, sharing of ideas, collaboration, and typing*:

> On the web because it helps other kids learn new things and it's fun typing. [Mandy, final interview]
>
> On the web because it just gives you a chance to show your ideas and thoughts. [Hazel, final interview]
>
> On the web because I don't really write in my journal. I don't really know what to put in there, but on the web, there's somebody else who can help you word it right or whatever when we are publishing. [Camrn, final interview]
>
> On the web because of typing, telling how to do it, and publishing. [Ande, final interview]

Two students had no preference for the Web journal or their own journal:

> It doesn't really matter. [Jeff, final interview]
>
> Either one's fine. I like to do them both. [Shanon, final interview]

Question 4: You know how we have a new student in this class or choose one of your friends who is not in this class. How would you explain what the web journal is all about to him or her?

Several key themes emerged from students' responses to Question 4. For some, the TMC was a place where students were able *to choose what to write and to talk about what they were learning*:

> It's fun because you get to type and pick what you want to write about. [Lynton, final interview]
>
> Every once in a while someone gets chosen to go and write about what we're doing in class, you can choose a subject. Like, how to find the sums of adding fractions and publish what you wrote. [Jake, final interview]
>
> When you publish, you write what you learned from one of the lessons and show how you did it. [Tinse, final interview]

In this sense, students seemed to distinguish between simply presenting problems or homework on the Web and actually writing about mathematics.

In contrast, some students were *more detailed about what to write* on the Web and suggested including "*solutions, how to do it, ideas and examples*:"

> You have to explain what you did in class and a solution for how to do it and give them a couple of examples. [Ande, final interview]

> You write what you did in class and how to do it, the instructions to do that paper or problem and write down the ideas. [Lin, final interview]

Other students emphasized the importance of the *audience* of the Web journal:

> You pick something, people and they publish it so other people can look at it.... To help other people on the Internet learn. [Tara, final interview]

> On the web, you have to explain to other people what you are doing and how the problems work. [Shanon, final interview]

It seems that writing to a remote audience outside the classroom is a recurrent theme in students' perception of the TMC.

Question 5: What is the purpose?

As presented in Table 4, 87.5% of the students explained that the purpose of the TMC was to *share ideas with other people* and 12.5% believed that the purpose was to use it as a *future reference*. Students did not only perceive an audience for their work, but thought it should be used to help others learn:

> ... to help other kids, like maybe in the X school district or all over, to help them if they don't know or if they are doing the same thing or if they want to see how other people are doing it. [Camrn, final interview]

Table 4. Distribution of Responses on Purpose of The Mathematics Chronicles

	n	%
Share ideas with others	14	87.5
Use as reference	2	12.5

As part of the purpose of sharing their work, students also thought the audience could read and respond to their entries. Along this line, people could also act as a sounding board for students' thoughts:

> I think to share your ideas. People respond to it. It's not really bad if they respond to it because you know that they are reading your stuff and listening to what you have to say. [Hazel, final interview]

Other students valued the Web journal as a *reference* they could review when having difficulty with future work:

> If you are stuck on something, you can go and look back. If you forget how to do something you can look back on your notes. [Ganton, final interview]

In addition, implying that the TMC is a supportive tool for collaboration, students suggested they could better understand their mathematics through other people's ideas:

> To remember things and if someone else published and you didn't understand something, you can go to their publication and read it and understand it. [Ande, final interview]

Question 6: What are important things to remember while publishing? Things that you shouldn't do?

There were three main themes from responses to Question 6. Some students simply gave a *general idea for what to write about on the TMC*. They could take

something from their homework:

> You could do whatever homework you did and explain how you did it. Like your homework, you can scan it through and write what goes with it and you can cut out stuff that doesn't. [Lynton, final interview]

And "if you find something interesting, you can publish it."

Second, because students perceived there was an audience, they believed authors needed to write their entries *properly by checking for grammatical errors and writing mathematical ideas that made sense*:

> Everybody can see it, your audience you are writing to. Use proper spelling, punctuation, all the editing stuff and make sure your information is correct. If it isn't, everybody is going to get messed up. [Abraham, final interview]

> Shouldn't tell them the wrong way to do a problem. Remember that everybody is going to read it. Make sure you have the right answer before typing it up. You shouldn't publish the wrong answer or the wrong way to write it. [Jake, final interview]

It seemed that the students' work might used as an authority on mathematical ideas, so authors needed to be especially careful with what they wrote. Other people would be reading their entries and possibly learning from their ideas, so students needed to make sure their publications would not "tell them the wrong way."

Finally, students not only emphasized the importance of writing grammatically correct or mathematically sound ideas, but also highlighted the significance of *writing how they arrived at a solution.* In publishing, students need

> to do it step by step. Like if you can say that these all go together, you have to say 2 and 2/5 plus this is what. Instead of just writing down what everything is altogether, go step by step and tell what you are doing. You should go step by step and add it together. [Jeff, final interview]

Similarly,

> remember to title your paper and tell what you are doing, to show it and don't just put some answers down. Make sure you show how to do it....Don't just put the answers, but make sure you tell what the questions are and what you did. [Lin, final interview]

When solving a problem as an entry, students valued the importance of including the problem as well as details about how to solve it. In this sense, one role of the journal was to explain to readers *how to do mathematics.*

Question 7: Now I am going to ask you about how you like publishing or how you find it interesting, whether you like publishing or find it interesting. So what do you think about publishing?

All but one said they did find the Web journal interesting, and there were several trends in students' responses for Question 7. They thought the Web journal was interesting to students because it enabled them to learn and to teach. Writing about their mathematics and collaborating with others *enhanced some students' understanding*:

> It's fun. I think that you should have it next year to help out the kids because this has helped me a lot in understanding the computer and math because I was a bad student. ... When I explain it on the computer, I know exactly what I am saying. That helps me out with my math. When we have partners, like smart people helping us, you get it because once you read it, you say, oh, now I get it. [Lynton, final interview]

Students could also use the TMC as a reference when they do not know "how to do something:"

> I think it's a good way to learn how to do different things and learn how to, for example, if you didn't know how to do something, you can go back and learn all different kinds of things. If you didn't know how to do something and somebody published it and you were looking around on the computer and found something you didn't know how to do and you read it and they explained it really carefully, you can learn how to do it. [Ande, final interview]

Others liked the TMC because it was a medium that allowed them *to support the audience's learning* as well:

> Publishing makes sense for people to do it, not like all those things that the teacher makes you have to do. It's something people want to do... because it is fun and if you are going to help someone else and if other people are going to help you. If there is someone else in another city trying to do a problem, I can write this down and try to help them if they have a problem with it. [Ande, final interview]

Only one student was not as interested as the others in writing her journal on the Web because "at first, it's kind of interesting, but it gets boring after a little bit" [Kyndi, final interview].

Question 8: How do you like publishing compared to other activities?

As Table 5 indicates, 87.5% of the students responded that they would rather publish compared to other mathematics activities. Like others, one student responded that he would rather publish than take a test, but in his case, he would leave worksheets as homework, so he can publish in class:

> I would rather publish than take a test or would publish and do the worksheets at home. [Jake, final interview]

Table 5. Distribution of Preference to Publish or Participate in Other Activities

	n	%
prefer publishing	14	87.5
prefer other activities	1	6.25
no preference	1	6.25

For others, publishing was more engaging because they had more ownership over the work:

> Yeah I like publishing, sometimes in class, it is boring, but when you get to publish, you can write down what you think about it, how you got the problem. [Camrn, final interview]

One student would rather participate in other activities, but could not explain why:

> I probably like the other things better. I don't know why, I just do. [Kyndi, final interview]

Finally, another person had no preference because publications were based on other class activities:

> It doesn't matter because I usually publish what I do in math class. [Shanon, final interview]

Question 9: Do you think publishing is different from other activities that we do in class (makes it fun)? How?
(Probe) Next year, we are thinking about having publishing but trying to understand whether we should have it. Do you think we should have it? Why should I have publishing? Or what is it about publishing that you like?
(Probe) How is it fun? What makes it fun?

Question 9 was used as a means for understanding why students would rather publish than participate in other activities or why they thought it was more fun by capturing how students thought publishing was different. As Table 6 indicates, most of the students (87.5%) reported that publishing was different. For some of these students, publishing is different from other math activities because the TMC allows for a *worldwide audience* and also enables students' to *author their work*:

> Because you get to use the computer, you get to put what you say, so everyone in the entire world can read it. You can put it in your own words, but you have to make sure other people can understand it. [Jeff, final interview]

Table 6. Distribution of Responses on Whether Publishing is Same or Different From Other Classroom Activities

	n	%
different	14	87.5
no difference	2	12.5

Others emphasized that publishing is different because although you may simply write the answer for other mathematics activities, it is *important to explain when publishing:*

> Publishing is different because with a worksheet, you just put down the answer, but with the publishing you have to explain your answer, how you got it. It's better to explain your answer than just right down the answer because if you get the answer from somebody, you can't explain it. But if you publish, you have to explain it. [Ande, final interview]

Finally,

> When you publish, you are not by yourself, and sometimes kids don't do the work because they have to sit by themselves or do it by themselves and don't understand it. But when you are publishing and you put down a problem, you have a friend there who can help you solve the problem or a friend who can help you think of a problem to put down. It is also fun because it lets you show other kids, not just those you are working with, it shows other kids. [Camrn, final interview]

In this sense, publishing is unique and captures students' interest because it supports collaboration among the writers and between the writers and the readers.

Two students did not believe publishing was significantly different from other activities because *instead of simply "doing" the work, students were writing about what they did*:

> Sort of because you write down what you did down in class, so it is sort of the same, but you don't just do it, you write about what you did. [Lin, final interview]

> Not really. You just talk about what you are doing. When you publish, you talk about the ditto sheet or what you did in class today. [Hazel, final interview]

Question 10: Do you think that publishing on the web leads you to do math or makes you want to do math more? Why?

As Table 7 indicates, a majority of the students (75%) agreed that publishing on the Web did make them want to do mathematics more. Through publishing, *students could develop new ways for approaching mathematics*:

> ... because when I publish I start writing something and think, oh my gosh, it does really work and start using it. [Mandy, final interview]

Table 7. Distribution of Responses on Whether Publishing Encourages Doing More Mathematics

	n	%
Yes	12	75.0
No	4	25.0

Similarly, while publishing, students are encouraged to think about what they are writing. Through this experience, they can better understand the ideas:

> Yeah, because it is fun. You get to learn more about what you are doing that way. That makes you understand it more. Once you think about it more to write it down, it makes you understand the problem more. [Lin, final interview]

In addition, it makes some students want to do mathematics more

> ... because you want to learn stuff. When others login, they can see your initials and decide to read yours. They can learn from them. I think it's cool. I get to see other solution strategies and I get more involved in math because I learn more stuff everyday. And I get to write more stuff. After I type stuff, I want to learn more about that subject and publish more on that subject. [Abraham, final interview]

In this sense, students may "get more involved" *because they learn from others and become more curious about the topic they discuss* in their own publications.

Of those who did not feel that publishing made them want to do mathematics more, one explained that it was, however, a way for her to "take a break while you are working."

Question 11: Have written in journals before? Published before? Read other student's journal entries on TMC?

Finally, Table 8 indicates what percentage of participants:

- had written in mathematics journals before this class,
- had published on the Web before this class, and
- had read other students' journal entries on the Web.

Table 8. Distribution of Experience with Journals or Publishing and Whether Have Read Others' Work

		n	%
Experience with journals	yes	6	37.5
	no	10	62.5
Experience with publishing	yes	0	0.0
	no	16	100.0
Read others' work	yes	10	62.5
	no	6	37.5

A large percentage of students had done journals before (62.5%) and generally indicated that previous journals comprised class assignments or solution strategies teachers recited to students. All of the students had not published before on the Web. Finally, a majority of the students (62.5%) had read other people's work.

Summary

Several recurrent themes emerged across the students' responses. The perception of a remote audience for the TMC was one significant theme students discussed that also shaped students' idea of the Web journal. Believing their work would be shared with an audience outside of the classroom, students emphasized the importance of explaining how they did mathematics and of grammatical correctness to enable understanding. In addition, publishing on the TMC was a forum for collaboration while writing entries or through responding to each other's work. Students claimed that through these interactions and through the care they took in writing their ideas, they not only learned, but also became more interested in mathematics learning. All of these points illuminated by students in addition to their perception that they had authority over their work published on the Web journal made the TMC an interesting activity that "makes sense for people to do."

To examine these themes in more depth, I present trends emerging from observations in and out of the publishing environment (Chapter 4) and from students' work done in the TMC and their individual journals (Chapter 5). Then, in Chapter 6, I present an analysis that highlights overall themes emerging from these three sources of data (interviews, observations, journals).

CHAPTER 4

STUDENT INITIATIVE IN PUBLISHING AND NONPUBLISHING CONTEXTS

Observations of student interactions were conducted throughout the project and included field notes, videotapes, and audiotapes. I focused on the data for the last few sessions (17 episodes) because it was at this point that students had experience in both the publishing and nonpublishing contexts. These were used to examine students' initiative in the context of publishing on The Mathematics Chronicles and of regular (nonpublishing) activities during the final phase of the school year. The purpose of this investigation was to understand, broadly, how students demonstrate initiative in a mathematics classroom and, specifically, how initiative may vary across the publishing and nonpublishing contexts.

Data collected in the final phase of the project includes each of the students in each context. For example, I observed Shanon in the publishing and the nonpublishing context during the last few sessions. In these episodes, students worked in small and whole groups.

Nonpublishing activities included whole class discussion of ideas, class and homework assignments as well as small group work. During whole class discussion, Mr. Watkins facilitated discussion by presenting or reviewing material and encouraging students to clarify or justify their ideas and strategies. He asked students to explain how they arrived at their solutions and to provide reasons for agreeing or disagreeing with their peers' arguments. In small groups, students collaborated on assignments and were encouraged to support each other in developing ideas, strategies, and solutions.

At the beginning of class, students either volunteered or were asked to write on TMC. In the publishing context, students worked with partners at the computers for the entire class period and completed entries by the end of class. Homework assignments, class discussion, or interests in previously studied concepts sparked students' ideas for an entry. Students worked together in dividing tasks, contributing ideas or criticisms, and composing the entries. While publishing, students were also expected to participate in the nonpublishing classroom activities, so they needed to attend and plan their time wisely.

Developing a Rubric for Initiative

Developing a rubric for initiative was a multi-step process. Before coding observations, I developed a draft rubric that included student interactions illustrating initiative. While reviewing the data for each of the episodes, I modified this rubric by coding for other interactions of initiative in mathematics learning. By analyzing each of the episodes more closely for a third time, I collapsed or refined the categories for initiative. Afterwards, I chose 3 episodes from the publishing and nonpublishing contexts (total of 6) that represented the range of initiative demonstrated across the 17 episodes. I will discuss these 6 cases in more depth later. After another thorough examination of these selected episodes, I developed categories that could be more broadly defined as different aspects of mathematics learning:

- mathematical sense-making,
- collaboration or working together in small groups, and
- management.

Within these broad domains of mathematical sense-making, collaboration, and management, there were several specific ways that students demonstrated initiative. Table 9 illustrates the different types of initiative students demonstrated under the broader categories of mathematics learning.

Table 9. Different Types of Student Initiative in Classroom Interactions

Mathematical sense-making: • deciding on a topic for the journal entry • defining the problem or task at hand • discussing mathematical ideas or strategies (procedure or visual aid to solve problem) • generating solutions for problems • explaining mathematical idea or strategy (talking about idea or strategy to reiterate them or to respond to partner's idea or strategy or to a question)
Collaboration: • ask partner for help in completing work • challenge, question, or ask for clarification on propositions or solution strategies • continue or modify work • edit for misspellings or revised the work so that it made sense
Management: • negotiate roles in task • decide upon resource to use (other than paper: calculator, overhead, ruler)

Before providing cases of what I credited as initiative for each specific domain, I present the 6 cases in more depth.

Snapshots of the 6 Targeted Episodes

The 6 targeted cases included 3 publishing and 3 nonpublishing episodes. I present snapshots of each episode to provide a clearer view of the students and the activities involved in the cases. In Table 10, I present the nonpublishing cases, and in Table 11, I present the publishing cases.

Table 10. Snapshots of Nonpublishing Cases

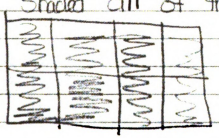
Context - Nonpublishing
Shanon and Mandy: Mr. Watkins started this class period by assigning work from the investigation, Adding and Subtracting Fractions. Students needed to add and subtract fractions of an advertisement page to find the cost of the ads. They had the entire class period to work with partners on the assignment. Mr. Watkins interrupted small group work on occasions to discuss students' questions or solutions. Shanon and Mandy began this episode by updating their individual journals in their notebooks, and soon after began completing their assignment. In this episode, these two were able to address a and b: 1. A local magazine sells advertising space. It charges advertisers according to the fraction of a page their ad will fill. a. For page 20 in the magazine, advertisers have purchased 1/8 of the page and 1/16 of the page. What fraction of the page will be used for ads? What fraction of the page will remain for other uses? Explain your reasoning. b. The Cool Sub Shop is having its grand opening and has purchased several ads. They buy three 1/4 page ads, four 1/8 page ads, and ten 1/16 page ads. What is the total amount of space that they have bought? Explain your reasoning. c. The magazine wants to make $160 for each page of advertising sold. What might the magazine charge for each size ad if ads can be any of the following sizes: 1/32, 1/16, 1/8, 1/4, 1/2, or a whole page? Explain your reasoning. d. Using the pricing scheme you developed in part c, what would the bill for the Cool Sub Shop be for the ads they purchased in part b? Explain your reasoning. (Lappan, Fey, Fitzgerald, Friel, & Phillips, 1996b, p. 49) The two worked together by asking for each other's help, offering ideas for solving the problems, and providing different ways for solving some of the problems. They drew pictures to represent fractions and also converted fractions into equivalents or converted improper fractions to mixed fractions to compare them. Through these interactions, the pair made some errors that led to explanations and development of each student's own solution to the problems. See Figure 7 for Shanon and Mandy's completed work.
Bali and Tara: Bali and Tara also participated in the activities defined by Mr. Watkins discussed above, but they addressed questions a-d. In solving the problems, the two also drew pictures to represent fractions or find equivalent fractions. They spent a great amount of their energy on explaining their strategies. In addition, conflicts between the two students' ideas and strategies led them to question, challenge, and explain the ideas and strategies. During these conflicts, Bali asked Tara to copy her answers, but Tara refused and individualized her work by providing her own solutions and explanations. See Figures 8 and 9 for Tara's and Bali's completed works.

Table 10 (cont'd)

Context - Nonpublishing
Tinse and Ande: Mr. Watkins began this class period by having one of the students read the introduction for the investigation, Finding Areas and Other Products. Then, students split into small groups to work on the following questions: Paulo and Paula are tending the brownie booth at the school fair. All evening long they have run into interesting situations in which they have to find fractional parts of other fractions. Let's look at some of the problems. Paulo and Paula had to solve while they were selling brownies. The brownies are baked in square pans, and they are sold as fractional parts of a pan. A whole pan of brownies costs $24 dollars. The cost of any fractional part of a pan is that fraction of $24. A. One pan of brownies was 2/3 full. Mr. Sims bought ½ of what was in the pan. What fraction of a full pan did Mr. Sims buy? How much did he pay? B. Paulo's aunt Serena asked to buy ¾ of what was left in another pan. The pan was half full. How much of a whole pan did Aunt Serena buy? How much did she pay? (Lappan et al., 1996b, pp. 54-55) While working together, Tinse and Ande provided strategies and solutions to problems and completed this assignment. After giving students some time to discuss these problems, Mr. Watkins called on a few students to talk about their solutions or to present their work on the overhead. After this whole group discussion, students were given an assignment to work in class and finish up at home if needed. Tinse and Ande worked on the following problem for the rest of the class period: The school fair was almost over. Paulo and Paula wanted to sell all the remaining brownies in a hurry, so they decided to offer a discount of 20% on all sales. They had 2 1/4 pans of brownies left. Remember, they originally sold a pan of brownies for $24. Mr. Vargas offered to buy half of all that they had left. A. How much will Mr. Vargas purchase? (Lappan et al., 1996b, p. 57) In solving this problem, Tinse had difficulty remembering how to find the percentage of an amount and requested help from the Mr. Watkins and me. Her requests for help were deflected as suggestions to ask her peers. During these interactions, Ande attempted several times to help Tinse and said to her partner that she was trying "to teach her." The remaining part of this episode involved figuring out how to find 20% of $24. See Figures10 and 11 for Ande's and Tinse's works.

1 a $\frac{3}{16}$. $\frac{13}{16}$. I drew a graph [ ] and divided into 16 squares. [ ] it says $\frac{1}{8}$ and $\frac{1}{16}$ so colored in $\frac{1}{16}$ and for every 8 squares I shad I in and that is how I got $\frac{3}{16}$.

b. $1\frac{7}{8}$ because we made all the denominator equivalent to each other (result: $\frac{1}{8}$ $\frac{5}{8}$ $\frac{6}{8}$) we took a box and shaded all of those in.



There wasn't enough room so we had to make another box

and that equals $1\frac{7}{8}$

Figure 7. Shanon and Mandy's responses

1. A) $\frac{3}{16}$ will be used for ads, and $\frac{13}{16}$ will be left because $\frac{1}{8} = \frac{2}{16}$ and you add $\frac{1}{16}$ on to that and you get $\frac{3}{16}$ and there will be $\frac{13}{16}$ left on the page.

B) $\frac{7}{16}$ because $\frac{1}{8}$ is $\frac{2}{16}$ and $\frac{1}{4}$ is $\frac{4}{16}$ and add $\frac{1}{16}$ and you get $\frac{7}{16}$.

C) $130.00 - because for $\frac{3}{4}$ is $120 then you add $10.

Figure 8. Tara's responses

1)

a) $\frac{13}{16}$ Because we divided a piece of paper into 16 squares and filled in 1 for $\frac{1}{16}$ then we turned to the back and divided it into 8 and filled in 1 for $\frac{1}{8}$ I figured that 1 square on the "8" side was equal to 2 squares on the "16" side so I filled in 3 all together on the "16" side and there was $\frac{13}{16}$ left so there was $\frac{3}{16}$ for Ads.

b) $\frac{7}{16}$ Because $\frac{1}{4}$ is a quarter of a page which on the "16" side is 4 squares so we added 4 squares.

c) 130$ 25¢ because for $\frac{3}{4}$ it is 120 and $\frac{1}{4}$ is 25¢ so it is 130$ and 25¢

d) 70$ because $\frac{1}{4}$ is 40$ and $\frac{1}{5}$ is 10$ each so it is 70$.

Figure 9. Bali's responses

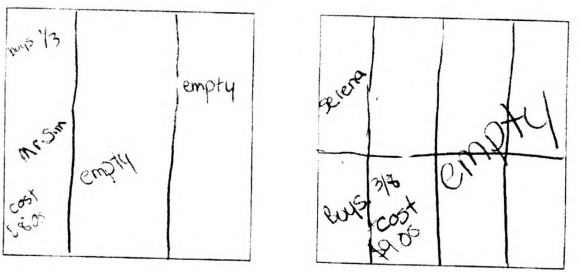


Figure 10. Ande's responses

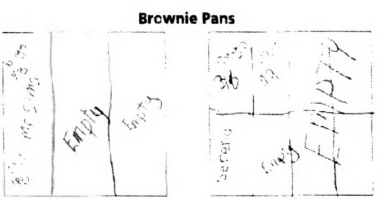


Figure 11. Tinse's responses

Table 11. Snapshots of Publishing Cases

Context - Publishing
Tara and Ande: Mr. Watkins began class by asking students to provide their algorithms for multiplying fractions. After a few students offered their algorithms for discussion, Mr. Watkins divided students into small groups to work on an assignment taken from the book. T and B discussed what they would publish for their TMC entry and developed an algorithm for multiplying fractions and provided an example. Each student shared in the typing and development of the entry. Their collaboration around the entry was like a coordinated dance between the students illustrated as continuations and modifications of each other's contribution. The following is their finished entry: **Making an algorithm** We were in math class and our teacher told us to find an algorithm. First of all we had to know what an algorithm was. An algorithm is a plan or series of steps. Then we chose 3/8 x 3/4. Then we need to know how to times fractions. First you multiply the numerator (the to number of a fraction) by the other numerator. Then you multiply the denominator (the bottom number of a fraction) by the other denominator. We got 9/32.
Kyndi, Lin, and Hazel: It had been a couple of days since students were in their mathematics class, so Mr. Watkins gave students time to review their homework assignment with their partners before handing it to him. Kyndi, Lin, and Hazel completed their work and wanted to publish. The group threw out a couple ideas for an entry and settled on a problem from the homework assignment. Most of their time was spent on editing and modifying their work so that it made sense. They also provided solutions and corrected errors they made during this episode to conclude with the following entry: **Finding the fraction cost of an advertisement page** This section is about adding and subtracting fractions. The problem asks you to use this pricing scheme to figure out how much it would cost for a person to buy: 3/4, 4/8, and 10/16 of a page. The prices are: 1 pg = $160 1/4 pg = $40 1/8 pg = $20 1/16 pg = $10 We figured out this problem by multiplying: 3x$40=$120 (=3/4), 4x$20=$80 (=4/8), 10x$10=100 (=10/16). Then we added $120+$80+$100=$300 So this person spent $300 on advertisements.

Table 11 (cont'd)

Context - Publishing
Bali and Camrn: Mr. Watkins reviewed a check-up with the students and during this discussion, called on students to provide how they arrived at their solutions. Afterwards, students were given time to discuss mathematical reflections on Finding Areas and Other Products. Bali and Camrn offered several different topics for their TMC entry and began the entry several times before settling on writing about comparing fractions. They drew pie graphs as a strategy to compare fractions and included their sketches as annotations to their written work: Comparing Fractions We drew pie graphs to figure out which fractions were greater, less than, or equal. We had 3/5 and 7/8, 12/15 and 3/4, and 5/8 and 10/16. See Figure 12 for the pie graphs Bali and Camrn drew to compare these fractions.

Understanding the Specific Aspects of Mathematical Learning

To understand how student initiative may be demonstrated in the mathematics classroom, I analyzed the specific ways that student took initiative. The following provide cases of what I credited as initiative for each specific domain. The unit for coding initiative was an utterance unless otherwise indicated. Since excerpts may include several different kinds of initiative, I highlight in bold those specific parts of the examples that illustrate the type of initiative under discussion. The interactions I excluded as initiative were those that students demonstrated at the teacher's prompting or leading.

Mathematical Sense-making

I suggest that mathematical sense-making comprised several kinds of interactions. Students first needed to *define the problem or task* at hand and/or *decide on a topic for their journal entry*. In addition, to work problems or compose journal entries, students often discussed *mathematical ideas or strategies*, and *generated solutions*. Learners also provided *explanations* of mathematical ideas or strategies. I considered all of these events as part of mathematical sense-making.

Deciding on a topic for a journal entry. While writing journal entries, students needed to first decide on what topic to write. This activity essentially begins mathematical sense-making because it becomes the subject of discussion between partners and in student work. I coded these instances as initiative in this domain when students decided for themselves what the topic of discussion would be for their journal entry.

Case of Shanon and Mandy (nonpublishing). Deciding on a topic for a journal entry might entail figuring out what generally occurred on particular dates as it did for Shanon and Mandy. In their case, Shanon and Mandy used class time to update their individual journals with statements about particular activities they accomplished for certain dates:

> Shanon: Did you get any more dates? Did you get any of these? [Asking Mandy whether she has completed journal entries for dates that Shanon has blank]
>
> Mandy: Did we take a practice test? This was a test and this was a practice test.
>
> Shanon: We had Spring Break, so when did we get back?
>
> Mandy: On the 7th.
>
> Shanon: Mhmm, 13th? [Replaying events to decipher what activities occurred on which dates]
>
> Mandy: Yeah.
>
> Shanon: Whatever. 13th. We took the practice test.
>
> Mandy: No, for the XXY [statewide test].
>
> [They both write in their journals]

In this scenario, Shanon and Mandy, along with the rest of the students, were given an assignment to work on in groups, but these two first used some time to catch up on the dates they had missed for their individual journals. They discussed generally what activities they did for each of the missing entries.

Case of Bali and Camrn (publishing). During publishing, students sometimes began their TMC entry with an idea of what to discuss for their publication. On other occasions, however, defining the topic unfolded as in the case of Bali and Camrn. These two students generated several ideas for their entry and finally settled on one. Camrn

began writing an entry and erased it to initiate another that Bali continued and modified. After some editing, Camrn decided to write their mathematical reflections[2] for the investigation on "Finding the fraction of fractions or whole numbers." Again, Bali decided that she wanted to publish something different and illustrated how to solve the following problem:

> While traveling in Mexico, Samantha found some beautiful ceramic tiles. The tiles are square, 6 1/2 inches on each side. Samantha wants to buy enough tiles to cover the floor of her sun room. The sun room is also square, 108 inches on each side. How many tiles does Samantha need? (Lappan et al., 1996b, p. 62)

By the end of this episode, however, Bali had decided to write on how they compared the following fractions and decided whether one was greater than, less than, or equal to the other:

3/5 __ 7/8
12/15 __ 3/4
5/8 __ 10/16

In this setting, Bali and Camrn had suggested several topics for their journal entry and finally settled on the last idea. I considered cases like this, with students demonstrating an effort to define and redefine the topic, to be initiative.

Summary. Students, sometimes, were quite thoughtful in deciding on a topic for their journal entries as Bali and Camrn demonstrated or, as Shanon and Mandy illustrated, simply remembered what activity the class completed for the day. In either case, it was during these interactions when students, themselves, were struggling with

---

[2]Reflections were student's overall summaries of mathematical ideas and solution strategies they learned during an investigation

formulating the topic of discussion for their journal that I highlight this kind of initiative in the different episodes.

Definition of the problem or task at hand. Similar to choosing a topic for journal entries, students demonstrated initiative by defining the problem or task at hand for mathematical activities other than journal writing because this defining illustrated students' active participation in addressing mathematical problems. In this case, learners exemplified effort in undertaking a task by asking other learners for clarification of problems assigned.

Case of Shanon *and Mandy (nonpublishing).* During nonpublishing activities, the teacher often defined the activities for the day. However, it was the responsibility of the students to be aware of the problems or assignments they needed to complete. In the following, Mr. Watkins had begun class and Shanon and Mandy were trying to determine what the task was:

Shanon: What are we supposed to do, right now?

Mandy: The heck if I know.

Shanon: What are we supposed to do? [turns around to JT to ask]

Case of Ande and Tara (publishing). In the case of Ande and Tara, the class had recently been given an assignment, but Ande apparently did not hear what it was and asked her partner:

Ande: What'd you say? What do we have to do?

Tara: 5-13.

Ande: We have to do 5-13.

Summary. In scenarios like these, students may have missed the assignment when it was given or were not paying attention at the time. I assert, however, that these students took initiative in defining the task at hand by demonstrating an effort in determining the assignment. It was in these kinds of instances when students attempted to begin the activities themselves without needing the teacher or researcher to remind them to complete their work that I credited students with taking initiative in this domain.

Discussing mathematical ideas or strategies. After establishing a topic or pinpointing the problem at hand, students may have discussed mathematical ideas or strategies. Through these kinds of interactions, I argue students took initiative by attempting to understand how to solve the problem.

Case of Tinse and Ande (nonpublishing). Tinse and Ande had the following problem:

> The brownies are baked in square pans, and they are sold as fractional parts of a pan. A whole pan of brownies costs $24. The cost of any fractional part of a pan is that fraction of $24.
> One pan of brownies was 2/3 full. Mr. Sims bought 1/2 of what was in the pan. What fraction of a full pan did Mr. Sims buy? How much did he pay? (Lappan et al., 1996b, p. 57)

Tinse and Ande attempt to solve the problem:

> **Tinse: Ok, we divide this [a pan of brownies] into 2/3.**
>
> Ande: We have to do [problem] A first.
>
> Tinse: That's what I'm doing. I'm dividing it. Divide it into 2/3.
>
> Ande: Oh, ok.
> ...
>
> Tinse: In Mr. Sims.
>
> Ande: That's not 2/3. What do you mean empty? [Tinse had shaded in 2/3 of the pan and indicated the remaining was empty because there was 2/3 left]

Tinse: It's empty, see cause 2/3.

Ande: Yeah and then.

Tinse: You divide it into 3 and 2 parts of it.

Ande: Ok, that's 2/3 of it, right? 1,2,3, right?

Tinse: That's in thirds.

Ande: Right, but that's not empty.

Tinse: Yes, it is. It says that one pan of the brownies was 2/3 full.
See?
...
Ms. Sims buys 1/2 of what's left in the pan. Oh, that's easy. We can divide this into 6ths instead.

Ande: (gasps)

Tinse: Oh, we don't need this into 6ths. Ok, he buys half of 2/3. So that's this. Mr. Sims buys this, right? [points to 1/3 portion]

Ande: Mr. Smith?

Tinse: Mr. Sims. Right, because he said he bought 1/2 of what was in there.
Right?

In this setting, Tinse first suggested a strategy of drawing a diagram of a pan and dividing the pan into 2/3, and second, to find 1/2 of this 2/3 portion, she suggested a strategy of dividing the whole pan into sixths. Instead, Tinse concluded that "we don't need this into 6ths" when she realized that 1/2 of the 2/3 left in the pan is obviously one out of the two pieces, which is 1/3. In this case, she tried a few different strategies to solve the problem.

Case of Bali and Camrn (publishing). While publishing on the TMC, students drew pictures as a solution strategy for solving a problem as well. As previously

mentioned, Bali and Camrn compared the following fractions:

3/5 __ 7/8
12/15 __ 3/4
5/8 __ 10/16

They scanned in Figure 12 as part of their journal entry and stated the following:

Bali: "We drew pie graphs to figure out"

Camrn: "To figure out if"

Bali: "which fractions were bigger or smaller."

Camrn: "which fractions were greater than, less than, or equal to."

This interaction along with Figure 12 illustrates the strategy Bali and Camrn used to compare the fractions. They drew pie graphs for each fraction and compared them to decide whether one pie had more pieces shaded or both pies looked like they had the same amount of pieces shaded. This comparison was used to decide which fraction was greater or whether they were equal.

Summary. During the various episodes, students drew pictures or used algorithms as strategies for solving problems, as in the mentioned cases. Students also demonstrated thoughtfulness about mathematical concepts such as what a fraction, decimal, percentage represents. I coded strategies and mathematical ideas under the same category because students' statements could be ambiguous characterized by either strategies or ideas. For example, in the case of Tinse and Ande, the strategy of dividing the pan into 6ths to determine 1/2 of 2/3 of the pan could also be interpreted as a mathematical idea. It was for these events when students attempted to solve the problem by offering a strategy or mathematical idea in the discussion that I credited students with this type of initiative.

Generating solutions for problems. Students not only discussed mathematical ideas or strategies, but also provided example solutions. Coding for students' solution of problems was at times intermingled with ideas or strategies, but since mathematical ideas or strategies may not have been mentioned alongside solutions, generating a solution was coded separately.

Case of Tinse and Ande (nonpublishing). Tinse and Ande illustrated how students may use several strategies until they solve a problem. In this case, the two attempted to solve the following:

> A whole pan costs $24. Paulo's aunt Serena asked to buy 3/4 of what was left in another pan. The pan was half full. How much of a whole pan did Aunt Serena buy? How much did she pay? (Lappan et al., 1996a, p. 55)

Tinse and Ande had figured out that Serena was buying a total of 3/8 of the pan and determine the cost of this portion by taking this fraction of the cost of the whole pan:

> Tinse: 3/8.
>
> Ande: Ok, she buys 3/8.
>
> Tinse: And how much does she pay?
>
> Ande: You have to take 3/8.
>
> Tinse: Ok, so 24 divided by 8 is 3 dollars. 3 dollars. It's 3 dollars. Wait it's not 3 dollars. It's 3 dollars for each.
>
> Ande: It's 3 dollars for each.
>
> Tinse: 3 dollars is for 1/8. But 3/8 is 9 dollars. She's only buying three.

In this episode, Tinse and Ande used a strategy to figure out how much 3/8 of the pan would cost. First they figured out that 1/8 of the pan would equal 24 divided by 8 or $3. With this information, they concluded that 3/8 is 3 times this amount, or $9, because 3/8 is 3 of the 1/8 portions. In this case, the focus was to solve the problem, so they

determined how much of the pan was bought by Serena and solved the problem of what this portion of the pan would cost.

Case of Tara and Ande (publishing). At times, students also generated solutions using an example to illustrate a mathematical idea without explicating the strategy or to simply solve a problem. In the following, Tara and Ande published a journal entry about how to multiply fractions and provide an example:

Ande: For example, 3/8. 3/8.

Tara: 3/8 times.

Ande: No and.

Tara: Put the multiply sign.

Ande: Times 3/4 would be. 9. 9.

Tara: 9 over 32.

In this case, Tara solved the problem of 3/8 times 3/4 and came up with 9/32. The goal in offering this solution was to explicate an example of how to multiply fractions.

Summary. As in these cases, students demonstrated initiative by taking it upon themselves to contribute to the mathematical sense-making by providing solutions without the leading of the teacher or researcher. They applied ideas or strategies to present examples of how to solve a particular problem.

Explaining mathematical idea, strategy, solution, or suggestion. As in the presented episodes, students were credited with taking initiative in explaining their ideas, strategies, solution, or suggestions when they offered the explanations without the teacher or researcher's request. I considered explanations as descriptions about the ideas or strategies in words that were provided when challenged or questioned by their partners'

or as a summary given at the end of a presentation of ideas, strategies, solution, or other suggestion.

Case of Tara and Bali (nonpublishing). Students often not only offered mathematical ideas, strategies, solutions, or suggestions, but also provided explanations. For example, Tara and Bali compared their explanations of what the total of 1/8, 1/4, and 1/16 of an advertisement page is in the following:

Tara: So, it would be 7/16.

Bali: Yeah. 7, because 1/8 is 2 pieces and 1/4 is 4 and 1/16 is 7. 7/16 because 1/4 is a quarter of a page which on the 16 side is 4 squares so we added 4 squares.

Tara: I put down because 1/8 is 2/16 and 1/4 is 4/16 and add 1/16 and you get 7/16.

Bali: Ok.

Tara: Ok.

In this excerpt, Bali and Tara had discussed strategies for solving the problem and at this point were reading their final explanations by explicating the strategies and ideas used to arrive at their solution of 7/16. Bali explained that 1/8, 1/4, and 1/16, altogether is 7/16 because 1/8 is 2, 1/4 is 4, and 2 plus 4 plus 1 is 7 or 7/16. She also explained that she found 1/4 is 4/16 because she drew two grids on her paper (one in sixteenths and one in fourths) and found that 1/4 of the fourths grid equals 4 pieces of the sixteenths. Tara provided a slightly different explanation that 1/8 is 2/16, 1/4 is 4/16, and adding them along with the 1/16 totals 7/16.

Case of Kyndi, Lin, and Hazel (publishing). Students also provided explanations of editing remarks. In the following episode, Kyndi, Lin, and Hazel tried to determine the total cost of a group of advertisement pages and needed to include the information

about the pricing scheme for different fractions of a page given in a different problem. Hazel typed how much different fractions of a page cost with the help of her partners, and Kyndi suggested they exclude the irrelevant information and explained why:

Lin: How about 1 whole?

Hazel: Equals $160.

Kyndi: Why are you doing one page?

Hazel: Because that is what it says.

Kyndi: Oh, you're writing down all the prices?

Hazel: Yeah.

Kyndi: You could just put 1/4 equals. You don't have to give the rest of the prices that you don't use. You could just put 4/8, sixteenth. [Makes an editing suggestion and explains]

Lin: Yeah, that would work.

Kyndi: Instead of doing all that. We don't really need that information. [Continues to explain the suggestion]

Hazel: Equals how much?

Kyndi suggested that they not include all of the prices because in their example, they only discussed the cost of some of the fractions. In this sense, Kyndi provided an editing suggestion and explained that they did not need to include other facts that would not be used in solving the problem.

Summary. Students provided explanations to compare responses to problems as in the case of Bali and Tara or as a response to partners' challenges or questions as in the case of Kyndi, Hazel, and Lin. Taking initiative in this domain was demonstrated in either of these scenarios as students exerted effort in contributing and clarifying each other's understanding. The distinguishing feature between the explanations and the

offering of ideas, strategies, solutions, or suggestions is that with explanations, students talk about how they generated them.

Collaboration

During small and whole group discussion, students collaborated and supported each other in several ways. They *asked partners for help in completing work.* Likewise, students took initiative in *challenging, questioning or asking for clarification* of partners' propositions or strategies. Also in assisting others, students *added to or modified* students' work or ideas. While publishing on the TMC, students were often concerned with grammatical errors and *edited collaborative entries for misspellings or revised them so they made sense.*

Asks partner for help in completing work. In mathematics learning, students may have difficulty making sense of a problem or solving it. Instead of looking to the teacher, who is typically viewed as the authority in the classroom, students may turn to peers for help. Along these lines, students take initiative by making an effort to employ their partner's assistance in solving or making sense of a problem.

Case of Shanon and Mandy (nonpublishing). Shanon demonstrated how students might solicit the help of their partners when confused about the problem. She read the following problem:

> A local magazine sells advertising space. It charges advertisers according to the fraction of a page their ad will fill.
> For page 20 in the magazine, advertisers have purchased 1/8 of the page and 1/16 of the page. What fraction of the page will be used for ads? What fraction of the page will remain for other uses? Explain your reasoning. (Lappan et al., 1996b, p. 49)

Afterwards, Shanon asked her partner, Mandy, for help because she did not understand the problem or how to solve it:

Shanon: 20, and they are advertising, which is 1/8 [reading the problem].

(idle talk about grandma)

Shanon: I don't get it. Help me.

Mandy: Listen to the problem. Listen to the question. "A local magazine sells advertising space. It charges advertising according to the fraction of a page"

Shanon: Yes.

Mandy: "their ad will"

Shanon: Yes.

Mandy: "fill. For page 20 in the magazine, advertisers have purchased 1/8 of the page and 1/16 of the page. What fraction."

Shanon: It's 2/16.

Mandy: Yes. No, it's 2/8. 2/8.

Shanon: It's 2/16 equal to 1/8, like I said before.

Mandy: No, it doesn't equal to 1/8.

Shanon: 2, it's divided by 2.

Mandy: Yeah, 2/8. I was right. It is 2/8. Ok, explain your reasoning.

Shanon commented, "I don't get it. Help me," as a request for some assistance from her peer in deciding how to approach solving the problem. Instead of ignoring the problem or avoiding her work, she took initiative by using her resources, her partner in this case, to make sense of how to tackle the problem. Mandy reread the question with her partner and the two began to peel away at possible solutions. Thus, Shanon demonstrated an effort to solve the problem by soliciting the help of her partner.

Excluded from this synopsis is the girls' continued discussion about how to solve the problem that concluded with a sensible solution.

Case of Tara and Ande (publishing). On occasions, students also asked their partners how to revise their work, particularly while publishing on the TMC. In the following excerpt, Ande and Tara wove together their entry about how to multiply fractions:

Ande: Times [Multiply]. Let me do it now.

Tara: Hold on.

Ande: And.

Tara: And then you get the answer.

(Ande typing)

Ande: And then you get the.

...

Ande: What do you want me to put after the answer?

Tara: For example.

Ande: For example, 3/8. 3/8.

Tara: 3/8 times.

Collaboratively composing this entry, Tara and Ande, each provided their additions. After a pause, Ande asked her partner, "What do you want me to put after the answer?" in an effort to invite Tara's contributions.

Summary. Although asking partners for help is demonstrated differently in the two settings, both pairs initiated or reinitiated steps towards approaching the task at hand by looking to their peers to make sense of the problem. In the process they also made an

effort to involve their partners in the problem-solving. I considered this type of action to be initiative because students were looking to their peers rather than teachers, who are often thought to have the "right answer." By requesting the aid of partners, students are taking initiative in involving their partners in more collaborative problem-solving and using other resources instead of turning directly to the teacher first.

Challenging, questioning, or asking for clarification on propositions or strategies. In response to partner's arguments or strategies, students often challenged, questioned or asked for clarification of the ideas and strategies. I considered these kinds of events to be initiative because students were taking some action in trying to understand their partners' propositions and strategies.

Case of Tinse and Ande (nonpublishing). In the following episode, Tinse and Ande needed to decide how to find out how much brownies would cost if they were 20% off, considering they cost $24 per pan:

Ande: Ok, take 24.

(Idle talk)

Ande: Then you take that.

Tinse: What are you doing? I don't remember that.

Ande: I am trying to teach you. And then you take 24 and divide it by 4.

Tinse: Why do you divide it by 4?

??: I don't know. Why do you divide it by 4, Ande?

Ande: Ok, listen 20% of 24 dollars, right?

Tinse: Yes.

In this setting, Ande attempted to provide a strategy for solving the problem by taking the 24 and dividing it by 4. Realizing that this did not make sense to her, Tinse questioned Ande's strategy, "Why do you divide it by 4?" Tinse was not accepting Ande's argument, but took initiative in making sense of the problem by demanding further explanation.

Case of Kyndi, Lin, and Hazel (publishing). While writing on TMC, students also asked for justification for what partners included in an entry. In the following setting, Hazel was typing the cost of different fractions of a page and her partners questioned why she was including some of the information:

Lin: Yeah, that would work.

Kyndi: Instead of doing all that. We don't really need that information.

Hazel: Equals how much?

Lin: $80.

Kyndi: I'd just do fourths, H, and then the 8ths, and the 16ths.

Hazel: I know. I'm not doing all of them. I'm not doing all of them.

Lin: Then why are you doing the ones that we don't need?

Kyndi: Why are you doing the half?

Lin: And the 1/3?

Hazel: You all are picky.

Although Hazel explained that, no, she was not including all of the fractions, Kyndi asked, "Why are you doing the half?" and Lin followed with "And the 1/3?" This setting exemplifies how students may challenge the work of their partners. It was along

these lines that the partners took initiative because they were not satisfied with Hazel's modification of the journal entry and made an effort to clarify or strengthen the work.

Summary. I considered events like these to be initiative because students were voluntarily seeking to make sense of their partner's propositions or strategies by challenging, questioning, or asking for clarification. At times, when students demonstrated this kind of initiative, they also provided alternative explanations, solution strategies, or missing information. Learners collaborated and pushed themselves and their group towards a clearer understanding of the mathematics through this process.

Continue or modify work. Contributing to the improvement of partner's work is often an important part of collaboration because it not only represents students' involvement, but also moves the task forward. In the analyzed episodes, students assisted each other by continuing or revising partners' ideas. It was during these events when students took a step into shaping work by providing suggestions on how their partner's could elaborate ideas, strategies, or explanations that I coded their interactions as continuing or revising work.

Case of Tara and Bali (nonpublishing). The case of Tara and Bali illustrates a typical situation in which a student modified the work of a partner. Tara and Bali were explaining how much of an advertisement page would be used and left over if 1/8 and 1/16 of the page was bought. The two had discussed how to solve the problem up to this point and were reviewing each other's responses to the question:

Tara: Ok, do you want to hear what I wrote?

Bali: Hold on.

Tara: Ok, 3/16 would be used for the ad and 13/16 will be left because 1/8 equals 2/16 and you add 1/16 to that you get 3/16 and there will be 13/16 left unused.

Bali: Mine is 13/16 because we divided a piece of paper into 16 squares and filled in 1 because there is 1/16. Then we turned to the back and divided it into 8 and filled in 1. I figured that 1 square on the 8ths side equals 2 squares on the 16th side so I filled in 3 squares altogether on the 16th side. I came up with 13/16.

Tara: And there were 13/16 left because we came out with 3/16.

Bali: Yes, and there was 3/16.

Tara provided her explanation and as Bali proceeded to read hers, Tara interjected with a suggestion of how Bali might modify her explanation, "And there were 13/16 left because we came out with 3/16" to elaborate what Bali meant by "came up with 13/16." In this case, Tara demonstrated how students took initiative in this domain by offering an explanation of Bali's answer.

Case of Tara and Ande (publishing). While publishing, students more often collaborated on one product than when working on the individual journals. As a result, partners took turns adding to each other's assertions. Consider the case of Ande and Tara. Their example illustrates how students often continued or modified each other's statements:

Ande: Wait, wait.

[typing]

Ande: [reads the entry].

Tara: We found out that the algorithm.

[Ande types].

Ande: The algorithm.

Tara: No.

Ande: That's what you told me to put. Then we chose to...

[typing]

Ande: We chose to put.

Tara: 3/8. Problems.

Ande: Fractions or problems? Fractions. 3/8.

As Ande typed, Tara added "We found out that the algorithm," and Ande continued with "We chose to put." Tara added, "3/8" and Ande revised this with "fractions 3/8..." In this scenario, the two were composing an entry explaining how to multiply fractions. Each student took a role in contributing to the development of the work, and through this process, the entry was transformed continually until each author approved the final product.

Summary. Contributing to the revision or continuation of partners' and collaborative work is an important demonstration of exerting effort in students' own and others' learning. Indeed in publishing and nonpublishing activities, students wove their ideas into their partners' or collaborative work. I suggest this willful action to shape a partner's or collaborative work demonstrates another way students take initiative in collaboration.

Edit for misspellings or revised the work so that it made sense. Students also edited work for misspellings and grammatical errors. In this way, learners addressed the syntactical problems to ensure that the product *made sense.* Initiative in this domain is demonstrated because students are making an effort to better develop the work. Since

there were no examples of this kind of initiative in the nonpublishing environment, I only provide an example from the publishing context.

Case of Tara and Ande (publishing). Ande and Tara illustrate how they collaborated in explaining that to multiply fractions you find the product of the numerators and the product of the denominators. Up to this point, they had written that "you multiply the numerator (the top number...)" and Tara added "to a fraction," but Ande edited the following, so it made grammatical sense:

Ande: Where am I at? A what.

Tara: To a fraction.

Ande: Of a fraction?

Ande continued the publication "you multiply the numerator (the top number" with "of a fraction." The final thought was "First you multiply the numerator (the top number *of a fraction*) by the other numerator." This event illustrates how students often made grammatical changes to the entries. In addition, students made spelling corrections, but in both cases, students took initiative in revising their work for publication.

Summary. In addition to modifying the work so that it made sense, students attended to the structural features of their work. In this sense, it seems students valued the appearance of their work. Student initiative was demonstrated as they made spelling and grammatical corrections by voluntarily contributing their ideas for how to make the entry more readable.

Other Management Tasks

Finally, students demonstrated the importance of management or organizational tasks. Students needed to *delegate roles* to work together effectively. Also, deciding on

what kinds of resources to use illustrates that students took initiative in managing tools that supported them in doing mathematics.

Negotiate roles in task. Negotiating roles was another important type of initiative that exemplified students taking some authority by deciding who would accomplish which parts of an activity. Although students' roles might be implicit, I explored ways students made their roles explicit by discussing their roles in a task.

Case of Bali and Camrn (publishing). During publishing, students decided who would type and which parts of the entry each would compose. For example, in one episode, Bali and Camrn had alternated in typing the publication, and Camrn asked her partner, "Do you want me to type that?" in an effort to redefine the typing roles.

On other occasions, students divided parts of the task by deciding who would solve which part of a problem. In either of these kinds of scenarios, students took initiative by taking it upon themselves to manage students' roles in the group.

Decide upon resource to use. Instead of asking the teacher or researcher how they should approach solving a problem, students, themselves, often chose tools to support their problem-solving. In the episodes analyzed, the resources excluded paper and pencil and included calculators, the overhead, and information from a previous solution.

Case of Tara and Bali (nonpublishing). Bali and Camrn needed to decide how much of an advertisement page 1/8 plus 1/16 would equal. In the following, Bali decided she wanted to use the overhead. Bali thought she could use transparencies to draw two grids: an eighths and a sixteenths. She had planned to overlap the eighths grid with the sixteenths to make sense of an equivalence from the sixteenths grid for the 1/8:

Bali: Mr. Watkins this is something we need the overhead for. Can we use the overhead for this? Because I need the transparencies.

Mr. Watkins: For what?

Bali: For the overhead.

[gets up and leaves for a moment]
[comes back]

Ok, we got all this. [Begins to solve problem by drawing grids.]

In this episode, Bali decided to use transparencies and the overhead as a resource for comparing drawings of 1/8 on a sixteenths grid. She spontaneously thought of this resource for helping her, thus taking initiative in solving the problem.

Case of Kyndi, Lin, and Hazel (publishing). In addition to using tangible tools (e.g., calculators, rulers, blocks, transparencies), students also selected relevant solutions for solving their problems. Kyndi, Lin, and Hazel were composing their entry and at the same time deciding how they would solve the problem. Kyndi realized that they needed to solve a different problem and use the information from the solution in order to solve the current problem:

Kyndi: To figure out how much.

Hazel: A person to buy.

Lin: Cost a person to buy a certain parts of a magazine.

Kyndi: Wait, wait, wait, if we do D, we're going to have to do C, kind of, but not explain, cause it says, use the pricing scheme, so we have to put the prices down, like one page is. So we have to put that information down.

Hazel: 3/4, 4/8.

Lin: 4/8 and 10/16 of a page. The prices are.

Demonstrating an effort to contribute, Kyndi suggested another piece of the puzzle, or resource, that would enable them to complete their entry.

Summary. Students may use abstract resources such as mathematical ideas or strategies to solve problems. They may also use tangible tools such as calculators, overheads, or information from previous problems to support their problem-solving. Students were taking responsibility for coordinating how to solve a problem instead of requesting the ideas of the teacher. In these events, students demonstrated initiative by attempting to make some progress with solving a problem through employing tangible resources.

Trends in How the Initiative Is Characterized Across the Contexts

In the discussed cases, I have illustrated the different types of initiative that students demonstrated in the nonpublishing and publishing context. These examples provide a clearer picture of the initiative that students took. Table 12 presents how often each type of initiative was coded in each case and the total number of times it occurred in the nonpublishing and publishing context. Although there were not enough cases to make a statistical comparison, this descriptive data can suggest some trends of initiative that characterize the nonpublishing or publishing context.

Overall, the initiative that students took in the nonpublishing context could be most characterized as

- clarifying tasks and
- offering or explaining mathematical ideas, strategies, solutions, or other suggestions.

The initiative that students took in the publishing context could be most characterized as

- deciding on topic for journal entry,
- asks partner for help in completing work,
- continue or modify work,
- edit for misspellings or revised the work so that it made sense,
- negotiate roles in task, and
- decide on resource to use (other than paper calculator, overhead, ruler)

Finally, challenging, questioning, or asking for clarification on propositions or solution strategies seemed to be a common way for students to demonstrate their initiative in both contexts.

Table 12. Frequency of Initiative Across Cases

	Nonpublishing Cases				Publishing Cases			
Type of Initiative	Shanon Mandy	Bali Tara	Tinse Ande	**Total**	Tara Ande	Kyndi Lin Hazel	Bali Camrn	**Total**
Deciding on topic for journal entry	2	0	0	**2**	1	7	4	**12**
Definition of problem or task at hand	1	2	5	**8**	1	0	0	**1**
Discussing mathematical ideas or solution strategies	9	17	12	**38**	2	2	1	**5**
Generating solutions for problems	4	7	4	**15**	2	4	2	**8**

Table 12 (cont'd)

	Nonpublishing Cases				Publishing Cases			
Type of Initiative	Shanon Mandy	Bali Tara	Tinse Ande	**Total**	Tara Ande	Kyndi Lin Hazel	Bali Camrn	**Total**
Explaining mathematical idea or solution strategy	9	18	5	**32**	2	4	3	**9**
Asks partner for help in completing work	1	0	3	**4**	4	5	4	**13**
Challenging, questioning, or asking for clarification on propositions or solution strategies	4	10	6	**20**	5	12	1	**18**
Continue or modify work	0	2	0	**2**	29	39	13	**81**
Edit for misspellings or revised the work so that it made sense	0	0	0	**0**	10	18	0	**28**
Negotiate roles in task	0	0	0	**0**	4	0	1	**5**
Decide on resource to use (other than paper calculator, overhead, ruler)	0	1	0	**1**	0	2	3	**5**

Summary

The analyzed episodes illustrate how students took initiative in different domains and suggest that nonpublishing and publishing contexts afforded different kinds of initiative. During nonpublishing activities, students tended to clarify tasks, discuss main ideas, strategies, or explanations, and generate solutions. Perhaps these tendencies arise from the nature of the nonpublishing context. First, students would be expected to clarify tasks because they are given an assignment. Furthermore, when students tackle more problems, they may have a greater opportunity to contribute mathematical ideas, strategies, explanations, and solutions. Students have more of these opportunities during nonpublishing activities because they work on more problems than during publishing.

Since TMC exists as a journal on the Web, it is not surprising that composing journal entries seemed to characterize the initiative students took in this context. In the publishing environment, students also tended to ask partners for help, continue or modify work, edit for misspellings or revise the work so it made sense, negotiate roles in the task, and decide on resources to use. Students' initiative may have been characterized by these types of interactions because, although they focused on fewer problems, they spent more time explicating their entries, so they would make sense to readers. In addition, because students were interacting around the completion of one piece of work versus separate assignments, they tended to demonstrate initiative characterized as collaborative and management-oriented. While publishing, students created a co-constructed product and may have been more interested in sharing and shaping the work. In this sense, I argue that, by interacting around one piece of work, students were more likely to collaborate on the publication in an interconnected fashion.

CHAPTER 5

COMPARING STUDENTS' WORK ON TMC AND IN INDIVIDUAL JOURNALS

I have presented interview and observation data to provide a sense of students' perception of the Web journal versus their individual journals and what kinds of interactions illustrate students' initiative in publishing and nonpublishing environments. In this chapter, I analyze students' TMC and individual journals to examine how initiative is manifested in their work. This examination complements and elaborates on themes that emerged from interviews and classroom observations. I also use this analysis of students' journals to understand what kinds of initiative characterize the work students accomplished in TMC or their individual journals.

As discussed earlier, TMC is a Web-based mathematics journal that is dynamically developed as students contribute their entries and responses to others' writings. Students usually worked with partners, but on a couple of occasions, wrote entries by themselves. TMC's organization is aligned with the Connected Mathematics Project (CMP) curriculum (Lappan et al., 1996a), so it is arranged into investigations (lessons) within units. Students were encouraged to write on the investigation they were learning at the time, but otherwise could choose the topic of their entry. In addition, students were not graded or given credit towards their grade for completing TMC entries.

Individual journals were also given to students to maintain. These journals were blank notebooks that each student was issued at the beginning of the year. The teacher credited students for writing in this journal daily and encouraged students to write something every day, so students' journals were organized chronologically. Classwork,

mathematical reflections, or general ideas, strategies, and explanations were the type of entries the teacher expected. After reviewing TMC, Mr. Watkins made announcements throughout the year that the kinds of entries they wrote on TMC should also be written in their own journals.

Analyzed entries included all 47 student entries on TMC, and 44 entries from the students' own journals. Since the entries from the TMC spanned the course of the project, I selected entries from individual work that also represented work over the course of the project. To make my selections, I determined the first and last dates of the TMC entries, as well as the date that fell in the middle of the entries, to represent key dates of the beginning, middle, and end of the project. Then I selected individual journal entries that were closest to the key dates for analysis. In a few cases, students discontinued writing in their individual journals before the end of the project, so I did not select entries for the end dates from these journals. I also excluded entries irrelevant to mathematical activities (e.g., workshop on self-control) and chose the individual journal entry second closest to the key dates for analysis.

Developing a Rubric

Before analyzing the journals, I drew from interview and observation themes to develop a draft rubric of components that might be apparent in journals. After reviewing the journals, I highlighted other components that seemed to occur in the entries to refine the final rubric that included the following:

- *general statements* about the activities accomplished for the day,
- *problems from class or homework assignments*,

- *main or mathematical idea* for the current lessons,
- *strategies or techniques for solving problems*,
- *example solutions* to problems,
- *explanations of ideas, strategies, or example solutions*, and
- *responses* to journal entries.

Comparing Entries from TMC and Individual Journals

Students took initiative in writing in TMC and their own journals by including these different types of components. To understand the kind of initiative students took in writing on TMC or in their individual journal, I used the rubric to review the journal entries a third time and coded for the different types of components. I coded each entry by indicating whether it included at least one instance of the component. I used this coding system to understand what percentage of entries from each journal included the component (see Table 13). I used these data to understand what kinds of components are more likely to appear in each journal with an overall goal of investigating further how students take initiative in writing on TMC or in writing in their individual journals.

Table 13. Percentage of Journal Entries Including Each Component

Component	Individual Journal %	TMC %
general statement	75.0	0.0
class or homework problems	6.8	40.4
main or mathematical idea	0.0	42.6
strategies or techniques	13.6	61.7
example solutions	11.4	87.2
explanations	6.8	78.7
responses	0.0	8.5

Understanding the Components of TMC and Individual Journal Entries

In the following data presentation, I provide an example of each component from each journal (when available), description of the component, and summary of the percentage of journals that included the component.

General Statements About Activities Accomplished for the Day

Students' individual journal entries often consisted of *only* general statements about the assignments they worked on for the class period and sometimes included statements regarding their affect (e.g., it was fun, boring, etc.). I included general statements in the rubric because of the high frequency of this component in individual journals, so coded TMC entries for it as well. Seventy-five percent of individual journal entries included only these general statements whereas none of TMC entries were limited to such general statements. In this sense, it was more likely that students would write these general statements as their entry in their own journal than on TMC.

Jeff's case (individual). Most students seemed to use their own journals as a log of activities for the day as in Jeff's case (Figure 13). Jeff wrote, "reread 5.2 and ACE questions, 1-5. Homework 5.3." His work represents entries commonly written in individual journals that only stated the problems completed or given for assignments.

Tara's case (individual). On occasions, students also included general feelings about the activities that they accomplished for the day. For example, Tara (Figure 14), wrote, "Today we did pg 23, we had to do the 2.4 follow-up on page 23 for our homework." Tara also expressed that "I like working with groups of people and Mr.

Watkins lets us do that." This entry illustrates how students mentioned whether they enjoyed an activity in their individual journals.

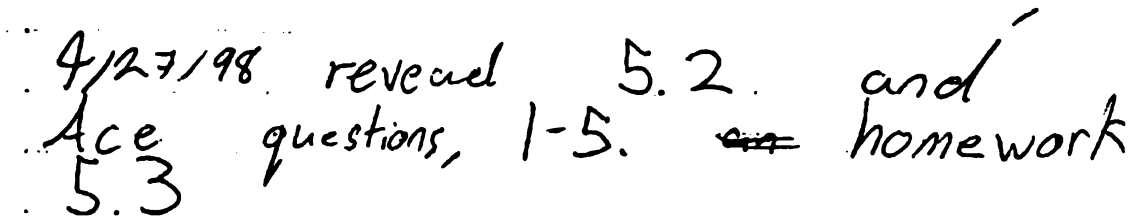


Figure 13. Jeff's entry includes a general statement about the day's activities.

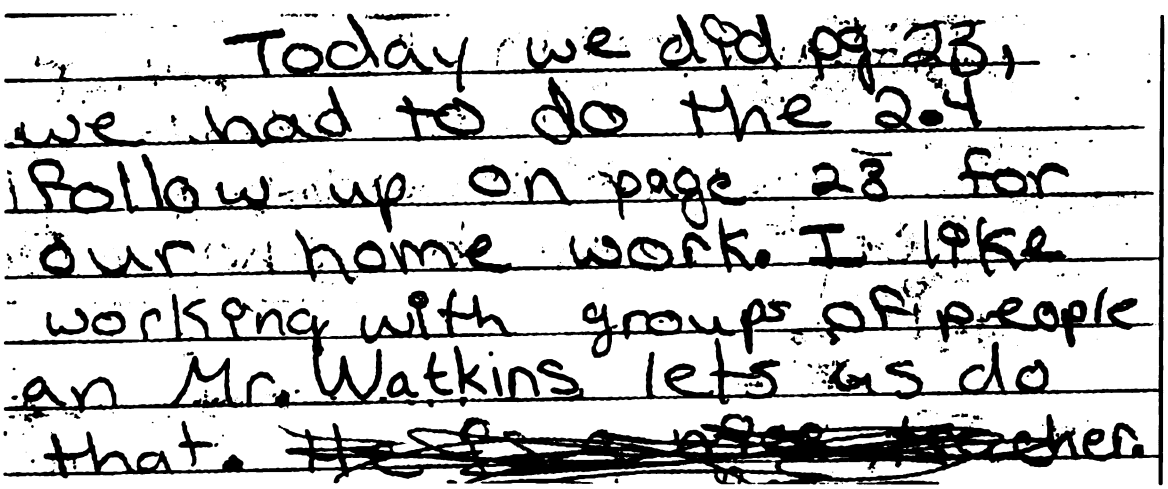


Figure 14. Tara's entry includes a general statement of the day's activities.

Problems From Class or Homework Assignments

Sometimes students included in their individual and Web entries, examples of the assignment they were completing. On occasions, students also wrote a short narrative about the main idea, solution strategy, or explanation, but at times, only completed problems in the journal as though it was a notebook for completed assignments. This component appeared in 40.4% of TMC entries and was more likely to appear in TMC than in students' individual journals where it appeared in 6.8% of the cases.

Shannon and Mandy's case (TMC). Shannon and Mandy's case (Figure 15) illustrates the kind of assigned problems students might include in the journals. In this event, Mr. Watkins asked students to write mathematical reflections about the investigation they recently studied, and Shanon and Mandy decided to publish this on TMC. As indicated, the two students completed questions 2 and 3. Question 3 is actually taken from the students' book and included in the entry: "When you multiply 2 whole numbers, the product is larger than the factors. Is the product of the 2 fractions larger than the fractions?" Students were expected to answer these reflections questions, providing some reasoning as evidence. Indeed, Shanon and Mandy answered the question by reasoning, "No, because every time you multiply a fraction the number gets smaller. This happens because when you break a fraction in parts it will decrease."

Mandy's case (individual). Students completed assignments in their individual journals as well. As Mandy's case (Figure 16) illustrates, however, students sometimes only provided the answers to assigned problems. In this case, Mandy solved "Problems 5.1 and 5.2" in her journal, but unlike Shannon and Mandy's entry above, did not include

Mathematical Reflection
By Shanon and Mandy

2.SOMETIMES WE SEE PROBLEMS LIKE 3/5 X 4/5 ALL YOU HAVE TO DO TO SOLVE THIS PROBLEM IS MULTIPLY THE NUMERATORS 3X4=12 SO THAT IS THE NEW NUMERATOR. THEN YOU HAVE TO FIND THE DENOMINATOR SO YOU MULTIPLY THE 2 DENOMINATORS 5X5=25. SO YOUR DENOMINATOR IS 25. YOUR FRACTION NOW IS 12/25. IN OTHER CASES YOU WILL END UP WITH ANSWERS LIKE 12/24. SINCE YOU CAN REDUCE THAT THEN YOUR ANSWER WILL BE 1/2.

3. QUESTION: WHEN YOU MULTIPLY 2 WHOLE NUMBERS, THE PRODUCT IS LARGER THAN THE FACTORS. IS THE PRODUCT OF THE 2 FRACTIONS LARGER THAN THE FRACTIONS. ANSWER;REASONING: NO BECAUSE EVERYTIME YOU MULTIPLY A FRACTION THE NUMBER GETS SMALLER. THIS HAPPENS BACAUSEWHEN YOU BREAK A FRACTION IN PARTS IT WILL DECREASE.

Responses

Would you like to respond?

Figure 15. Shanon and Mandy's entry including problems from class or homework assignments.

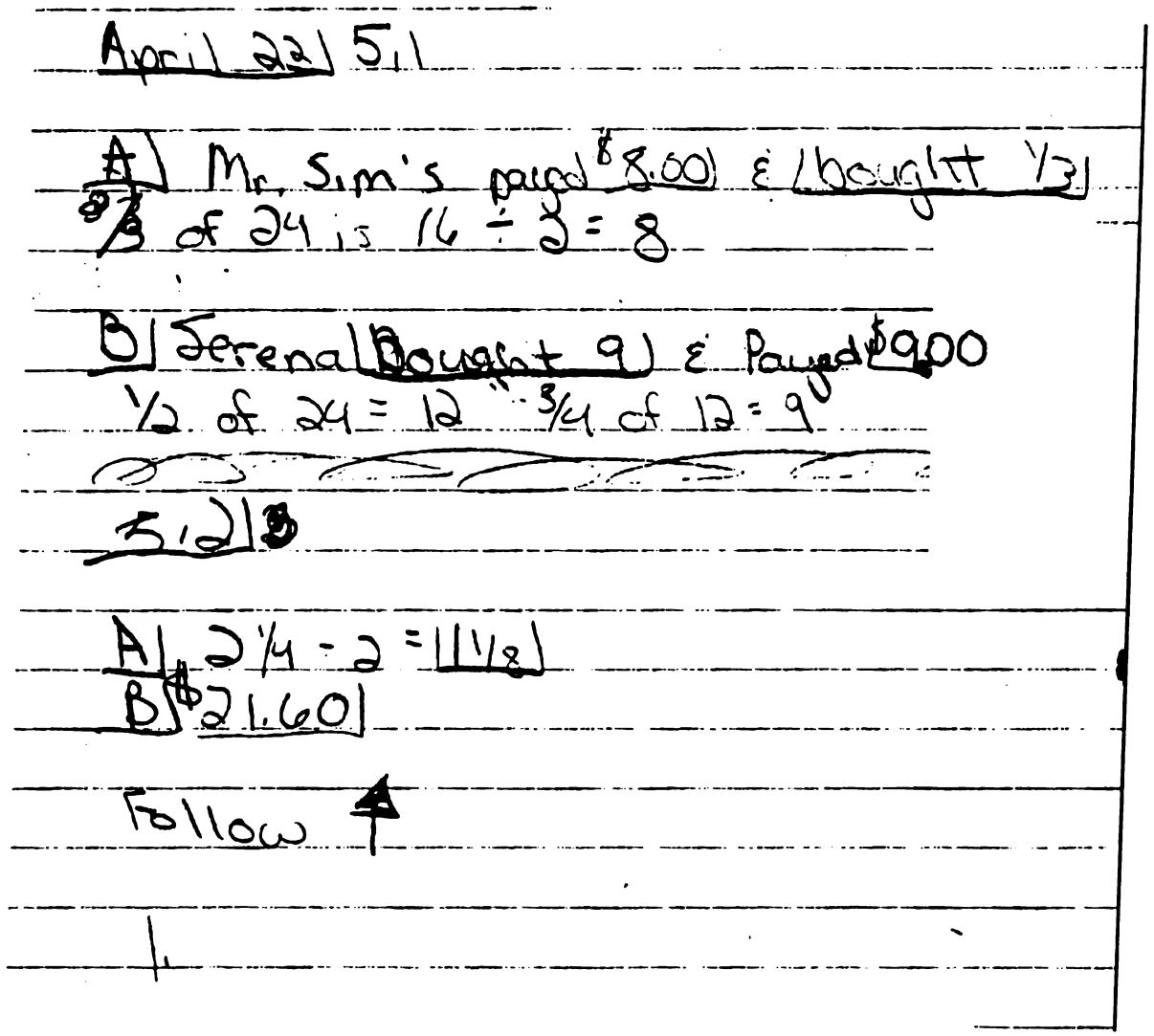


Figure 16. Mandy's entry including problems from class or homework assignments.

the context of the answer. For example, she wrote "Mr. Sims paid $8.00 and bought 1/3," but did not include the problem she solved. As a result, it is difficult to decide what question she addressed. Mandy's example represents other cases of student journal entries that demonstrated the completion of assignments, but provided little explanation of the context or reasoning behind the answers.

Main Idea for Current Lesson

I coded the two journals for main or mathematical ideas because some students claimed in their interviews that they wrote them in their individual journals as well as they did on TMC. Main ideas included general statements about the topic students discussed (e.g., "over the last few weeks, we have been learning how to reduce fractions, rename fractions as decimals or percentages") as well as more specific mathematical ideas, including definitions (e.g., definition of fraction), labeling of mathematical expressions (e.g., top number of a fraction is the numerator), and mathematical relationships (e.g., "we are putting fractions into decimals"). This component occurred in 42.6% of the TMC entries and none of the individual journals.

Ganton and Justin's case (TMC). On some occasions, students made *general* statements about the mathematical ideas they were learning in TMC publications. Ganton and Justin's entry (Figure 17) is a short description of the topic students reviewed along with a part of an assignment they completed in class. They wrote that the main idea they explored for the week was "working on adding and subtracting fractions."

Lin and Camrn's case (TMC). Lin and Camrn's entry (Figure 18), which illustrates how students also wrote about more specific main ideas, depicts the authors'

Tupelo township
By **Ganton and Justin**

In this lesson we have been working on adding and subtracting fractions. Lapp owns 1/4 of the town. Bouk's area multiplied by 4 equals Lapp's total area. Bouck's area is 1/16 and Lapp's area is 4/16 of the town.

Responses

In this lesson we have been working on adding and subtracting fractions. For example Lapp owns 1/4 of the town. Bouk's area multiplied by 4 equal parts is equal to Lapp's total area. Bouck's area is 1/16 and Lapp's area is 4/16 of the town. 4/16 is equal to 1/4 of the town.

Lynton and Tinse

Would you like to respond?

Figure 17. Ganton and Justin's entry including main idea for current lesson.

Fractions into Decimals
By **Lin and Camrn**

We are putting fractions into decimals. For example, today in class, we had to figure out the fractions of the vegetables in Justin's Garden. Then we had to take the fractions and put them into decimals. We had to take the number of vegetables which was out of a 100 square meters. For example, on one of them, we had to figure the least amount of potatoes we could have in the garden. And the other one, we had to find the highest amount of potatoes. We still had to get all of the other vegetables in the garden. One example is 60/100 equals 0.60 To get this, we had to first count all of the vegetables out and write them down as fractions and then put the fractions into decimals. To change the fraction into decimals, we knew that the hundredths stands for two over on the right side of the decimal.

Responses

Would you like to respond?

Figure 18. Lin and Camrn's entry including main idea for current lesson.

understanding of decimals. In this setting, students reviewed how to change fractions into decimals. The main idea that Lin and Camrn wrote was "To change the fraction into decimals, we knew that the hundredths stands for two over on the right side of the decimal." They considered this idea in concluding that "60/100 equals 0.60." This entry exemplifies how students wrote about main ideas by labeling mathematical expressions, in this case a decimal, and translated that knowledge into relating fractions and decimals.

Strategies for Solving Problems

Again, I coded for strategies (drawings or algorithms) in journal entries because students claimed they wrote them in both journals and to understand whether students indeed took initiative in this domain. As students affirmed in their interviews, strategies were quite common in their TMC journal entries, but contrary to what some students claimed, were rarely apparent in their individual journals. It was more likely to appear in TMC where it was included in 61.7% of the entries than in individual journals where it was included in 13.6% of the entries.

Tinse and Camrn's case (TMC). Tinse and Camrn's case exemplifies how students used drawings as solution strategies. In this case, Tinse and Camrn needed to determine what percentage of Figure 19 was shaded. Figures 19 and 20 illustrate that the students decided that considering the whole pie was 100%, they could "divide it into 4 pieces," and discover that one piece was equal to the "eaten" (shaded) portion, that is "25% or a quarter of the pie." Their solution strategy was to sketch a picture that divided the rest of the "circle graph," so that each portion would equal the shaded piece. Tinse

Finding what one piece of a Pie Graph is
By **Tinse and Camrn**

Circle graphs,or pie charts,is a kind of graph that shows how a whole (100%)is divided into several categories. On the pie chart that we drew someone ate 25% of a pizza.75% is left of the pizza. We found out that someone ate 25% of the pizza by thinking of the pizza as 100% or as a whole.Then divided it into 4 pieces so each piece is 25%.So if 1 piece is eaten then we know that someone ate 25% or a quarter of the pizza.
This is by:
Tinse and Camrn

pie

Responses

Would you like to respond?

Figure 19. Tinse and Camrn's entry including strategies for solving problems.

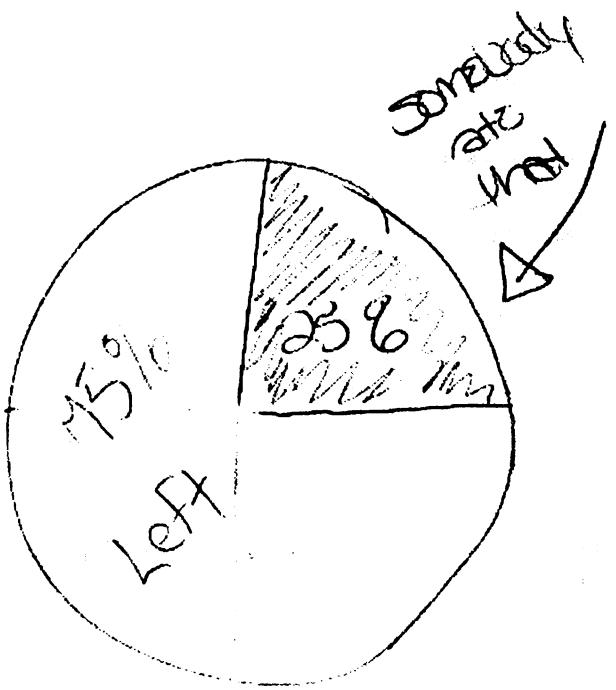


Figure 20. Pie graph representing 25% and 75%.

and Camrn concluded four of these pieces made a whole or 100% and decided that the shaded portion was 1/4 or a quarter of the 100% which came to 25%.

Hazel's case (individual). Students also used algorithms for strategies as depicted in Figure 21. During the events surrounding the writing of this entry, students were learning how to determine the equivalent percentage for a given fraction. Hazel knew fractions based on hundredths could easily be converted to percentages because a percent was a portion out of a hundred. Therefore, she developed a strategy for deciding how to change fractions so that it was based on hundredths. She concluded that "if the denominator... is not 100, you multiply" the denominator so that it is 100. Then, "you take the number of how many (numerators) and you multiply by that number," the factor of 100 or the number you multiplied the denominator by, to get the numerator. The converted numerator and denominator would presumably result in the equivalent fraction "based on hundredths." Hazel also added that if the denominator is greater, you divide it so that it is 100. In this case, the student did not provide a thorough explanation of the strategy because it needs to be assumed that the numerator is also divided by the same factor. The written explanation may not include all of the details of the strategy because it was written for herself so that she can make sense of her notes. This entry clearly indicates a procedure Hazel can use under different circumstances for deciding the equivalent fraction based on hundredths or percentage for a given fraction.

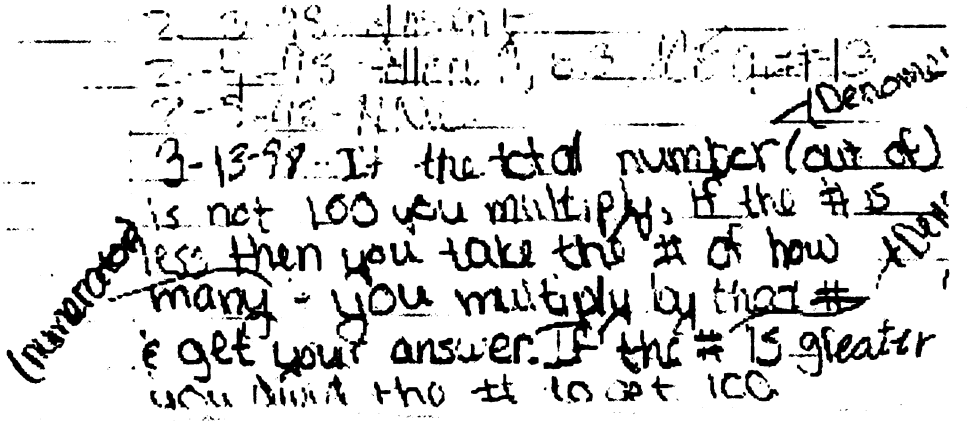


Figure 21. Hazel's entry including strategies for solving problems.

Example Solutions to Problems

Students' entries also included solutions or the answers to problems, and I analyzed journal entries for this component to examine whether students took initiative in this domain. I coded students' work for solutions that employed ideas or strategies students discussed to distinguish them from simple answers. In both of the following settings, students may have solved a problem, but in the latter, only provided an answer. Example solutions were more common in TMC entries (87.2% of the entries) than in students' individual journals (11.4% of the entries).

Shanon and Mandy's case (TMC). When explaining a strategy, students often included an example, as in the case of Shanon and Mandy (Figure 22). They provided a strategy for finding the percentage for a given amount when the percentage is a multiple of 10% (i.e., "10, 20, 30, 40, etc."). In addition, they provided examples of how to use

the algorithm. For instance, to find 40% of $34.00, the students took "10% of 34.00=$3.40, then multiply $3.40 by 4," and provided an example solution using the strategy:

Example: 3.40
x 4
$ 13.60

Finding Percents
By **Shanon and Mandy**

When finding percents that are multiples of 10; 10, 20, 30, 40, etc. first find 10 percent.
EXAMPLE: $ 34.00 10% of 34.00 = $3.40

If your looking for 40%, Then multiply $3.40 by 4; 2 if your looking for 20%, etc.
EXAMPLE:
3.40
x 4
$13.60
So 40% of $34.00 would be $13.60

Responses

Would you like to respond?

Figure 22. Shanon and Mandy's entry including example solution.

Lin's case (individual). At times, students simply wrote about the main idea and provided an example solution, as in Lin's case (Figure 23). While writing this entry, Lin wrote the class "corrected homework [and] took a test on multiplying decimal," and also provided "an example of a problem we did:"

```
  3.07
x 2.06
 4842
 000
 614
6.3242
```

In this case, Lin solved this problem to demonstrate how to multiply decimals.

Explanations of Ideas, Strategies, or Example Solutions

In their interviews, students claimed that it was important to "tell how to do it" and "explain the problems and answers" in the Web journal. I analyzed TMC entries to examine whether students indeed provided explanations of their ideas, solution strategies, or solutions and also studied students' own journal entries for explanations to compare work from the two journals. Students were more likely to provide explanations in TMC (78.7% of the entries) than in their individual journals (6.8% of the entries).

I distinguish explanations of ideas, solution strategies, or solutions from only presenting ideas or solution strategies because to qualify as explanations, students needed to be more explicit by *writing* about the ideas, solution strategies, or solutions *in words*. For example, in Figure 17, Ganton and Justin stated the main idea of the investigation, adding and subtracting fractions, but neither explained what adding and subtracting meant mathematically nor how to do it. The following two cases provide a better sense of the kinds of explanations students wrote.

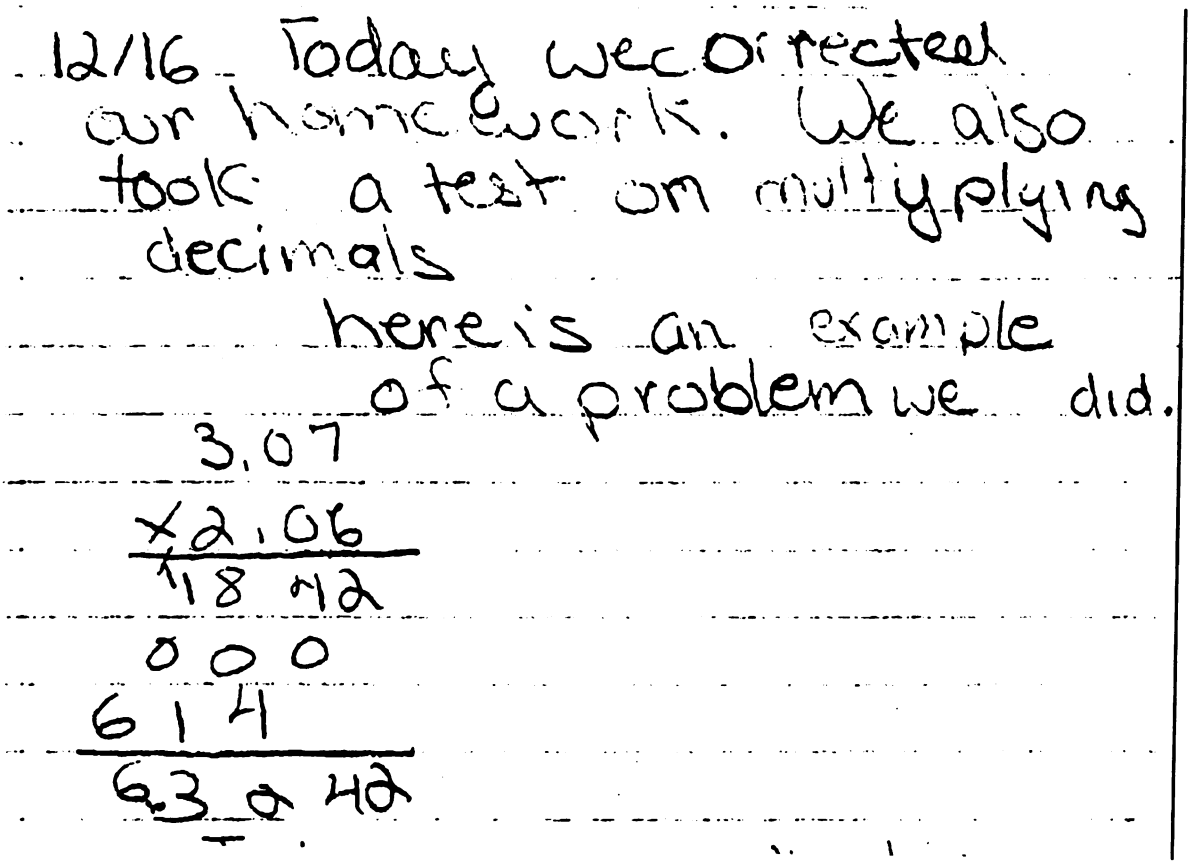


Figure 23. Lin's entry including example solution.

Kyndi, Lin, and Hazel's case (TMC). Kyndi, Lin, and Hazel's case provides an example of how students explained their solutions. In this case, the students included a problem from an assignment and determined the total cost a person incurred by buying 3/4, 4/8, and 10/16 fractions of advertisement pages. They provided all of the information needed to solve the problem including the fractional costs of a page and explained how they solved it, indicating,

> We figured out this problem by multiplying: 3x$40=$120 (3/4), 4x$20=$80 (=4/8), 10x$10=100 (=10/16). Then we added $120+$80+$100=$300. So this person spent $300 on advertisements.

In this scenario, the students explained how they solved the problem. For example, they knew that 1/4 of a page cost $40, so to find the cost of 3/4 of a page, they calculated 3 times the cost of 1/4 of a page or $40. They continued to explain how they found out what "this person spent" by writing "then we added $120+$80+$100=$300."

Dana's case (individual). Although rare in students' individual journals, some of the entries included explanations. Dana's entry (Figure 24), similar to the case in Figure 23, provides an example of how students explained strategies. Unlike Lin, Dana did not provide a solution, but explained how to find an equivalent fraction that is based on hundredths for a given fraction. I consider cases like hers to be explanations because she wrote in words "how to do it," instead of simply writing an algorithm such as the following:

$\underline{A}$ with B>100: $\underline{A}/? =$
B $\quad B/? = 100$
$\underline{A}$ with B<100: $\underline{A} \times ? =$
B $\quad B \times ? = 100$

This example presents an algorithm with variable manipulation to find an equivalent fraction that is based on hundredths, whereas the entries that I consider explanations included some kind of description.

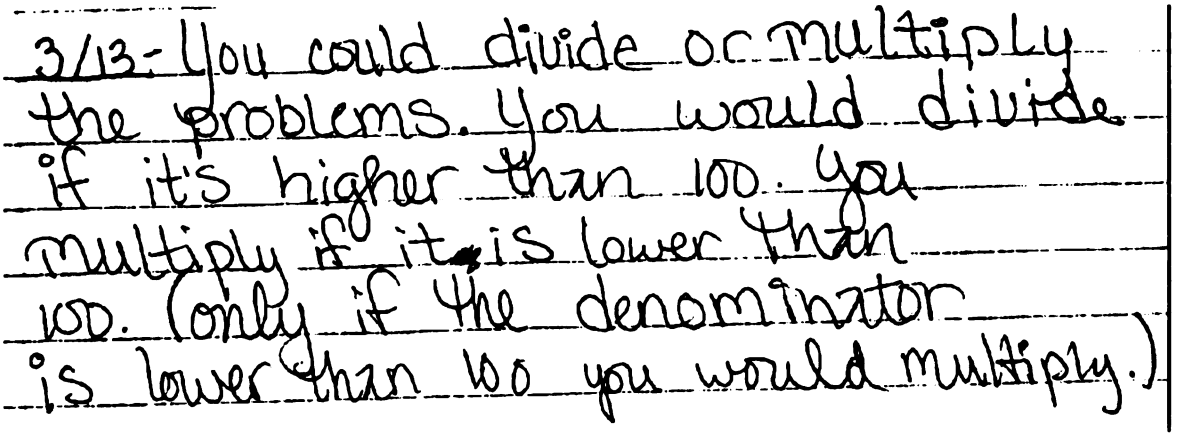


Figure 24. Dana's entry including explanation.

Responses to Peer's Journal Entries

Writing responses to the entries of their peers was another aspect of the TMC students enjoyed, as indicated in their interviews. At times, students read TMC from home or school and tried responding to others' work or added to entries that they wanted to revise themselves. I coded TMC entries to determine whether students indeed contributed responses to the Web journal. Only a small percentage, 8.5%, of TMC entries were responses, but the responses written provide a window into how students can view the TMC as a collaborative journal and an avenue for supporting each other's work.

Lynton and Tinse's case (TMC). In responding to their peers' entries, students may have simply elaborated on the publication to provide a better explanation as in the

case of Lynton and Tinse (Figure 25). They read Ganton and Justin's entry, which explained that the class was "working on adding and subtracting fractions." Lynton and Tinse, however, were not satisfied with the authors' example. Ganton and Justin took an example from their assignment and wrote that Lapp owns 1/4 of the town and that Bouk's area multiplied by 4 equals Lapp's total area. They then concluded that Bouk's area is 1/16 and Lapp's is 4/16. Lynton and Tinse responded to the entry with "4/16 is equal to 1/4 of the town." In this case, they provided a connection between the claim that Lapp owns 1/4 of the town or 4/16 of the town by indicating that 4/16 and 1/4 are equal.

Lynton, Justin, and Tinse's case (TMC). Whereas some students may have elaborated on others' ideas to provide a better explanation for Web entries, other students provided completely new strategies that made more sense. For example, Figure 26 illustrates that Bali provided a solution and explanation for how to add fractions when the denominators are different: "If it was 2/5 + 2/4, the answer would be 4/5 because when you have 2 fractions with different denominators you always go with the bigger number," the denominator. Lynton, Tinse, and Justin responded by providing other strategies: They purported that 2/5 + 2/4 would be 9/10 "because when you change it into decimals 2/4 would be .5 and 2/5 would be .4. Then you add it together and you end up with .9 which is the same at 9/10." They also provided another strategy of solving the problem through drawing pie graphs. After shading 2/4 of the whole (or half of the whole) plus 2/5, they discovered that 1/10 was left, so 9/10 was the shaded portion or the parts that were added together. In this case, the group responded by not only providing an explanation, but also challenging the ideas of the author and presenting evidence of their mathematical ideas and solution strategies.

Tupelo township
By **Ganton and Justin**

In this lesson we have been working on adding and subtracting fractions. Lapp owns 1/4 of the town. Bouk's area multiplied by 4 equals Lapp's total area. Bouck's area is 1/16 and Lapp's area is 4/16 of the town.

Responses

In this lesson we have been working on adding and subtracting fractions. For example Lapp owns 1/4 of the town. Bouk's area multiplied by 4 equal parts is equal to Lapp's total area. Bouck's area is 1/16 and Lapp's area is 4/16 of the town. 4/16 is equal to 1/4 of the town.

Lynton and Tinse

Would you like to respond?

Figure 25. Lynton and Tinse's response to previously written entry.

Adding fractions
By **Bali**

2/4+2/4= 4/4 because we took the numerator and added them together. We left the denominator the same. So the answer is 4/4th's. If it was 2/5 + 2/4 the answer would be 4/5th's because when you have 2 fractions with different denominators you always go with the bigger number.

Responses

Today I am going to explan how to add fraction.2/4+2/4= 4/4 because we took the numerator and added them together. We left the denominator the same. So the answer is 4/4th's or equivialant to 1 whole.. If it was 2/5 + 2/4 the answer would be 9/10th because if you change it into decimals 2/4 would be .5 and 2/5 would be .4. Then you add it together and you end up with .9 which is the same as 9/10th. You all so can do 2/4 plus 2/5 would equal 9/10. I got that because 1/4 plus 1/4 equals 2/4 which is half a whole plus 1/5 plus 1/5 would equal 2/5. 2/4 plus 2/5 would leave 1/10 left so that is why I got 9/10.

Lynton, Tinse, and Justin

Would you like to respond?

Figure 26. Bali's entry providing a solution and explanation for how to add fractions when the denominators are different, and Lynton, Tinse, and Justin's response.

Summary

This analysis indicates that individual journals were likely to include only general statements about activities students accomplished for the day, whereas publications in TMC illustrated more detailed entries. TMC were more likely to include main ideas, strategies, and example solutions (student-generated and class or homework problems). Students were also more likely in these entries to explain in words the ideas, strategies, and solutions. In addition, as students indicated in their interviews, some students responded to peers' entries.

The range of components students included in their TMC and individual journal entries provides another view of how students demonstrate initiative through their work. Overall, students wrote more substantively rich and clearly written entries in TMC than in their individual journals. Since it was more likely that students would include more of the various components in TMC, entries written on the Web were more likely to be elaborate and specific.

CHAPTER 6

WEAVING AN UNDERSTANDING OF INITIATIVE

A broad goal of education has been to prepare students for novel situations beyond the everyday tasks of school. Researchers have argued that some learners may have difficulty connecting their school knowledge with practices in the workplace or the community, but may still develop their own ways of thinking or approaching problems in out-of-school settings (Nunes et al., 1993; Resnick, 1987). Many have proposed ways of supporting learners in taking a more central role in the development of their mathematics thinking and learning (Cobb et al., 1992; Ball, 1992; Lampert, 1987; Schoenfeld, 1989) to prepare them for authentic problem-solving situations.

In beginning this work, I conceptualized student initiative as another way to describe, understand, and promote learners who direct and own their learning. I defined initiative as comprising volition, ownership, action, and effort. I suggested that students taking initiative make decisions about how to proceed with solving a problem and author the ideas or ways to approach the problem. In this sense, learners have the executive control and come to own their work because they are the creators of it. Instead of taking a passive role of knowledge consumption, initiative calls for students who take an active role by generating their own mathematical thinking. Through all of these activities, students demonstrate initiative through their efforts to move forward in completing tasks or solving problems.

A main agenda of this study was to move beyond this general conceptualization of initiative to better understand specific ways students can demonstrate initiative. In

Chapters 3, 4, and 5, I presented results from students' final interviews, observations of student interactions in and out of the publishing context, and a comparison of students' individual journals and TMC entries. In this chapter, I use these results to consider how students took initiative in these contexts. Then, I highlight the salient themes emerging across these data sources to provide an understanding of what aspects of TMC environment afforded or hindered different ways students demonstrated initiative. Along with examining these themes, I revisit the design principles and how they are related to the initiative and factors promoting initiative. Throughout this discussion lies the contribution of this work in establishing a richer sense of the conceptualization of initiative.

What Does Initiative Look Like?

To provide a better understanding of initiative, I intended to go beyond my initial definition to examine what initiative looked like in the classroom. In this sense, I wanted to begin the work needed to enable educators to recognize initiative. This research reveals initiative as reflected in students' interactions and in the written products of their efforts.

Initiative in Interactions in Publishing and Nonpublishing Contexts

Analysis of student interactions in the publishing and nonpublishing contexts revealed that students take initiative in different ways. In addition, the kinds of initiative demonstrated could be categorized into three broad domains of mathematics learning -- mathematical sense-making, collaboration, and management. The following review highlights the particular ways that students indeed took initiative.

Mathematical sense-making. Mathematical sense-making entailed learners' efforts to understand the question or problem confronting them, mathematical ideas, and ways of approaching the problem. Just as a painter decides the subject of her work and owns the complexity of each stroke for finishing the painting, students taking initiative in mathematical sense-making come to an understanding of a problem and then navigate the path towards solving that problem.

I suggest that to begin the process of mathematical sense-making, students first *decided on a topic for a journal entry*. At times, students were quite thoughtful about their journal entry topic by deciding on a subject; at other times, they simply reported what activity the class completed. Although students differed in how thoughtful they were in deciding on a topic, they showed initiative in all of these ways of deciding on a topic. Students may have also begun a task by defining the problem. In these cases, they may not have heard the assignment, but took initiative by attempting to determine the task by asking others in the classroom. Initiative in these ways reflected student effort in determining the task that also fueled their engagement in solving the problem. Determining the journal topic, problem, or task created the boundary for discussion and launched students into mathematical sense-making.

These kinds of events were described as initiative, in contrast to cases in which students made these kinds of decisions by following the lead of the teacher or researcher. Such contrasting scenarios might include students talking about off-task subjects and failing to launch into mathematical sense-making until the teacher or researcher approaches them to suggest several topics for a journal entry or to remind them of the assignment. In these scenarios, although students may have chosen a topic or announced

the assignment, they did not take the first step, themselves, in making these decisions; rather, they waited for the prompting of an adult.

Students also demonstrated initiative in mathematical sense-making by *suggesting mathematical ideas or strategies* and *generating solutions* to problems. They proposed concepts such as the relationship among fractions, decimals, and percentages; used pictures or algorithms to solve problems; and applied ideas or strategies to present examples of how to solve a particular problem. These actions constituted initiative because students were trying to make sense of the concepts and how to use them in solving mathematical problems. Students took this kind of initiative in response to peers' requests for help or in tackling the various steps of a problem. The time they spent on discovering the ideas and strategies that lead to solving a problem rather than simply determining the answers highlights the effort and action-- the initiative that they took in their learning.

Fostering initiative in this particular area is a key to promoting learners who are the originators of ideas or strategies and who follow through with applying them to solve problems. As encouraged by the NCTM Standards (1991) and the National Research Council (1989), students moved beyond merely learning the facts and procedures and began owning their meaning. Suggesting ideas, strategies, and solutions illustrate ways students examined, transformed, applied, and communicated (National Research Council, 1989) their knowledge in solving problems. The knowledge was not simply transferred from an authority; rather it was learned and transformed by the students. Therefore, taking initiative in this realm requires knowledge producers leading the discussion rather than echoers or followers of a teacher.

Finally, students took ownership in mathematical sense-making through offering *explanations of the mathematical ideas, strategies, solutions or editing suggestions* by expressing in their own words what these were. Students may suggest mathematical ideas, strategies, solutions, or editing remarks, but the distinguishing feature between suggestions and explanations is that students talk about *how* they generated them. For example, a student may suggest the solution for the addition of 1/8, 1/4, and 1/16 as 7/16, but also provide an explanation that it is 7/16 "because 1/8 is 2/16 and 1/4 is 4/16 and add 1/16 and you get 7/16" (Tara and Bali interaction). Some students provided explanations to compare responses to problems, and others used them as a means to respond to their peers' challenges and questions. Initiative in this area led them towards representing, proving, and communicating (National Research Council, 1989) what they thought or learned.

Taking initiative in providing explanations is crucial to developing learners who can reexamine how they think about problems and peers who can benefit from others' knowledge. Through offering explanations, learners reflect on their own thinking as they articulate their thoughts. This process of communicating more than a simple statement of a concept, procedure, or answer for a problem requires students to organize their thoughts into an effective explanation. Therefore, students' own ways for solving problems (Wood & Sellers, 1996) are crystallized out of their thoughts and presentations. In addition, peers can learn from the expertise or knowledge of their partners (Brown et al., 1993) by trying out ideas with one another and interconnecting their contributions towards one or several ways of thinking about a problem.

Students thus took initiative in mathematical sense-making through determining the task and discussing or explaining their ideas, strategies, solutions, and revisions.

Collaboration. Collaborative interactions are another broad domain within which students took initiative. In these events, learners directed their requests and support towards their partners.

Students worked together and assisted each other by *asking partners for help* in completing work rather than automatically turning to Mr. Watkins first for direction. On occasions, students who needed clarification of the problem or were at a standstill about how to tackle a part of the problem asked peers how they might approach it. In these events, by relying on their partners for support, students were attempting to initiate or reinitiate steps towards approaching the task at hand. Initiative in this area illustrates the effort and action students exert in continuing the path towards solving a problem in contrast to events in which students asked partners for help only after the teacher or researcher encouraged them to turn to their peers. Students were acting out the behaviors without taking initiative by relying on the teacher or researcher rather than assuming the control or making the effort to collaborate with peers.

In addition, students demonstrated that *challenging, questioning, or asking for clarification on propositions and strategies* was important in understanding their partners' thinking and the problem they were solving. These interactions were sparked by conflicts between students' and peers' thinking or confusion about partners' ideas and strategies instead of the requested direction of an adult. Through these interactions, students' initiative was demonstrated as they took an active role in eliciting their partners' thinking. This kind of initiative is significant because it promotes an environment where

students push the group further in understanding what they are learning and in reaching a resolution for the problem.

Finally, students worked together through *continuing or modifying each other's ideas* and *editing for grammatical or spelling errors*. While writing TMC entries, students supported their peers by elaborating on and revising the co-product. As their partners typed or contributed additions, students chimed in with their suggestions. Events such as these illustrate how learners took initiative by offering their assistance on their own accord, rather than through the lead of an adult to revise their work, and in this sense, established ownership for the work.

Management of tasks. Also important in mathematics learning was students' management of tasks through *negotiating roles* or *deciding on resources to use* (e.g., calculator, overhead, ruler). While publishing a TMC entry, students decided what parts of a problem each would work or who would type. In these cases, students took action by making executive decisions to organize or plan, dividing tasks, and choosing what tools to use. This kind of initiative is significant in establishing expectations for who will be accountable for what part of a task.

Students generated mathematical ideas to use and apply in solving problems, worked with their partners, and managed the roles or tools. By taking initiative in these three broad domains, students demonstrated effort in solving a problem or task. Learners not only showed action on their part in their interactions with partners, but also owned the work as the generators of ideas, strategies, and solutions.

Initiative in the Written Work

Students' written work in their individual journals and TMC entries provides further evidence for various kinds of initiative. Some student entries consisted of only general statements about activities accomplished for the day. For example, one entire entry consisted of, "Problems 4.2 and 4.3"; another consisted of, "We watched a video on mathematics, and it was fun." On other occasions, students wrote more substantive and detailed entries that included examples of assigned problems, main ideas, strategies, example solutions, or explanations. Compared to entries that included only general statements, the more extensive journal entries provided richer descriptions of the ideas discussed, how students could use these ideas, examples applying the ideas, and students' own words to clarify what they were trying to convey. These entries reflected student initiative in their thinking, contributing of ideas, and making decisions about appropriate information to include. This initiative is significant because through these kinds of actions, students are likely examining their thinking and advancing their learning.

Some students also showed initiative in collaborating by writing entries that were responses to the work of others. In these cases, students offered a different way of communicating the topic of discussion by providing more sensible ideas, strategies, example solutions, and explanations. This kind of initiative reflects students' active role in shaping their peers' work and extending the ideas in the publications.

Extending the Understanding of Initiative and Its Relationship to Prior Research

In introducing this study, I suggested that initiative connoted action, ownership, volition, and effort. Analysis of students' interactions and written work have shown

student initiative to be reflected in multiple ways--all illustrating action on the part of the students through their contributions, challenges, and requests. Students in this study gained ownership as they, themselves, generated the decisions, ideas, and solutions to problems, and contributed this knowledge through collaborative interactions or their written work. Aligned with the goals of other researchers (e.g., Brown, 1993; CGTV, 1991), students came to own some of the knowledge and shared it among others and, in the process, generated their own solution methods and made their own decisions.

A number of researchers have examined concepts that I would term initiative:

- formulating or challenging different arguments and justifications (Cobb et al., 1992; Wood & Sellers, 1996; Yackel et al., 1991),
- making decisions (Lampert, 1987; Scardamalia & Bereiter, 1994),
- developing own solutions (CTGV, 1992), and
- pursuing own topics (Schwartz, 1993) or defining a task (Schoenfeld, 1989).

These researchers were focusing on particular issues and were promoting different ways to enhance mathematical thinking and learning. Drawing from and building upon these researchers' ideas, I propose that initiative encompasses all of these kinds of interactions and is a common thread running through them. Whereas these researchers emphasized different ways of thinking and learning, the focus in this study is the underlying general characteristic of a learner, initiative or action on the part of the student in taking the lead in their thinking and learning.

Extending beyond previous research on how to enhance students' role in their learning, this work shows other ways that students take initiative. This study suggests that student initiative plays out in other kinds of interactions and the work that students

produce. It continues other researchers' examination of how students can collaborate in mathematics thinking and learning (Cobb et al., 1992; Wood & Sellers, 1996; Yackel et al., 1991) by emphasizing the significance of asking partners for help and continuing or revising each others' ideas. Along the same line, though Schoenfeld (1989) mentions the importance of metacognitive skills in problem-solving, this work suggests that initiative in other management skills--negotiation of roles or determination of resources to use--supports the organization and progress of a task. Finally, initiative was evident in the care and effort of students as they created elaborate and sensible entries in TMC, which implies that student initiative is demonstrated not only in their interactions, but in their written work as well.

As important, this work highlights that students may demonstrate these kinds of interactions without taking initiative. In one scenario, students may define their own questions, generate their own ideas, strategies, or solutions, request or provide assistance to their peers, and challenge peers' thinking, all with the lead and prompting of a teacher. These events play out as students continually turn to a teacher to provide scaffolding by reminding students to think on their own and collaborate. This kind of scenario illustrates students demonstrating the kinds of interactions that other researchers and I promote, but not the taking of initiative. In this work, I have emphasized that initiative requires students to take the first step. Learners, themselves, need to take the responsibility to lead the discussion and thinking. I believe other researchers (e.g., Cobb et al., 1992; Lampert, 1987; Schwartz, 1993) would agree that they were also promoting initiative in this sense, but my work emphasizes its role and link between their ideas.

Students' initiative in the discussed areas mirrored the effort they made in moving the task forward or in attempting to understand the problem. In each of these events, initiative led learners towards accomplishing tasks and engaging them in thinking about the ideas around their work. As a result, initiative laid a path for students to take a more self-directed *and* central role in their thinking and learning.

This work enriches our understanding of initiative by providing examples of how students may take initiative in a mathematics classroom and by framing initiative in relation to previous thinking about how to encourage students to take a more central role in their learning. I suggest, however, that this study is only a first step towards understanding initiative and how it is demonstrated. Student initiative may look different in other contexts that vary, for example, by subject matter or classroom culture. In addition, the kinds of interactions or other evidence for initiative may emerge from studies that include other data sources (e.g., incidental interviews focusing on students' perceptions of their role).

Types of Initiative Vary Across Contexts

Another focus of this study was how students' initiative varied across the settings in which they worked. In their interviews, students expressed an overall preference for TMC publishing over other mathematics activities and writing in their own journals. They said they enjoyed writing journal entries on the Web, thought it was interesting and "made sense for people to do." Many students requested opportunities to publish and would even leave class assignments for homework so they could work on TMC. It was clear that students valued publishing by recommending in their interviews that learners in

other classes should have the opportunity to write on TMC as well. For some, teaching the audience made publishing an enjoyable and worthwhile activity:

> If you publish and let everybody see it, you feel happy because you taught somebody how to do something that they didn't know how to do. [Ande, final interview]

A further discussion of the kinds of initiative taken and comprehensive analysis of TMC context reveal how this environment afforded or was limited to some forms of initiative.

Analysis of the student interactions suggests that the kinds of initiative students took differed across the publishing and nonpublishing contexts. The initiative students took in the publishing context included:

- defining a topic for TMC entry,
- asking partners for help,
- continuing or modifying work,
- editing for misspellings or revising so the entry made sense,
- negotiating roles in the task, and
- deciding on resources to use.

These types of initiative were largely collaborative and management-oriented; students' actions centered on supporting each other and organizing plans in order to work through a task.

In contrast, the initiative that students took in the nonpublishing environment included:

- clarifying tasks and
- suggesting or explaining mathematical ideas, strategies, solutions.

The kinds of initiative in the nonpublishing environment seemed in some ways more focused on mathematical sense-making than did the initiative demonstrated in the publishing environment. Initiative in the nonpublishing environment entailed narrowing down the purpose of the task and examining the ideas or solutions.

Recognizing some differences between nonpublishing and publishing context might inform why the initiative demonstrated in the contexts tended to be different as well. First, the publishing environment may limit how often students took initiative in *discussing* main ideas, strategies, solutions, or explanations, primarily because students focused on fewer problems for the publication than in the nonpublishing environment. As a result, because they worked on more problems, students tended to discuss and explain ideas, strategies, or solutions in the nonpublishing context. In contrast, while publishing, students spent more time explicating and revising thoughts to develop richer entries for TMC rather than focusing on multiple problems.

In addition, student initiative may have been more collaborative and management-oriented in the publishing than in the nonpublishing context because learners were co-constructing single pieces of work rather than completing separate products. Consequently, students needed to be more aware of sharing and making their own contributions to shaping the work when publishing than during nonpublishing activities. Although student initiative differed between the nonpublishing and publishing contexts, the student actions in both settings were significant in moving the task forward and supporting students' reflection on the ideas and solutions.

Analysis of students' entries in TMC and individual journals also revealed differences in the kinds of initiative students took. Students tended to limit their

individual journal entries to general statements about the activities for the day. These entries usually consisted of a few words or a couple of sentences regarding what assignment students were given or how students enjoyed the day's activity. Thus, students did not appear to take much ownership or initiative in the writing of their individual journal entries.

In contrast, students' TMC entries tended to be more elaborate and included:

- class or homework problems,
- main ideas,
- strategies,
- example solutions, and
- explanations.

TMC entries were the products of student action and effort in creating a detailed, sensible publication. Initiative in this respect is significant because it represents students' involvement and willingness to compose a purposeful entry.

In one setting, students *discussed* main ideas, strategies, explanations, or solutions, and in another, they *wrote* them in journal entries. When writing on TMC, students believed they could "put what they want to publish" and choose a topic they were learning in class. In this sense, students expressed ownership of TMC publications, and indeed, took initiative in generating a subject for their entries, often making several attempts before settling on an idea. It seems that students did not take as much initiative in *discussing* main ideas, strategies, explanations, or solutions while publishing as in nonpublishing activities; *What they wrote* in publications, however, included more of these components than did their individual journals. Examination of the interactions

suggests that students tended to take more initiative in mathematical sense-making in the nonpublishing than publishing environments. Students' written work, however, revealed that they were taking initiative by thinking about the ideas, strategies, or solutions to write about them. In this sense, interactions reflect student initiative in their actions whereas written work reflects initiative in their thinking.

How TMC Environment Supported Student Initiative

In addition to these arguments for why initiative varied across contexts lies an explanation that was illuminated through weaving overall themes from the interviews, observations, and journal entries. Several themes emerged from data analyses to suggest how initiative was fostered in the publishing context. The *perception of an audience, learning and teaching others, ownership,* and *collaboration* emerged as underlying themes for why students took initiative in TMC environment. In addition, these themes illustrate the significance of the design principles used as the basis for the TMC environment. In the following sections I discuss the significance of the themes and reflect on their relationship to the design principles.

Perception of an Audience

Other people can read TMC. A key theme of the TMC environment was students' perception of an audience. Students emphasized repeatedly in their interviews (see Appendix D for a list of relevant responses) that a unique feature of writing on the Web is that "everybody can read it." Authors perceived an audience beyond their classroom and argued that people "outside the classroom, not just Mr. Watkins or Ms. Jones," could read the publications. However, since I do not have documentation of

anyone visiting the site, it is difficult to determine whether students indeed had an audience outside of the classroom. Regardless, students *perceived* an outside audience and claimed the importance of the possible readers in motivating them to work with more enthusiasm and initiative in authoring the publication than in other mathematics activities.

Students' consideration of an audience was made evident when they highlighted their goals of editing and revising work so it made sense to the reader. Authors emphasized that since everybody could see it, students should "make sure [the] information is correct" and "use proper spelling [and] punctuation." Otherwise, "people will get messed up." The importance of writing sensible journal entries was a salient theme in students' interviews that explains why authors were so meticulous when taking initiative in this area when publishing.

You can be the teacher and you can learn how to do it. The educational value of TMC (see Appendix E for a list of relevant responses), a theme related to a perceived audience, was highlighted in students' interviews and helps to explain why students were so careful with *what* they wrote in their entries. TMC was a medium by which authors could *teach* "other people on the Internet [to] learn." On the Web, students "could be the teachers," something they could not do when writing in their own journals where their "teacher was the one reading it." In this sense, students thought they could help learners outside the classroom from other districts as well as from a wider community. A remote audience could learn how authors solved the problems, "if they are doing the same thing;" could receive help on other topics they are learning "if they are having problems with it;" or could "see if anybody has put anything they did not know."

In addition to "helping other people," students stressed the role of TMC in their *own learning*. The process of publishing extended their learning as they examined various topics new and old to students and discovered strategies to realize "it does really work and start using it," or through writing and thinking about TMC entries, students "understand it more." Through writing entries, students had a chance to revisit and reflect upon the points made in the publications and, as a result, learn more about the topic.

Students also alluded to the role of TMC in their own learning by saying they could use it as a reference or review it to learn new mathematics. "If someone else published and [students] didn't understand something, [they] can go to their publication and read it and understand it." When authors "explained it really carefully," students could review previous entries to resolve problems or questions they might have about mathematics they did not know or "to see how other people learn math instead of only the way you learn."

Finally, students emphasized the importance of the reader's option to respond to their work. Through this interchange, authors could learn from the suggestions readers made "to get better ideas of what they have been doing," but to provide some feedback as to how authors may revise their writing or ideas in the entry. Some students did take initiative by using this capability to respond to peers' work and offer alternative ways of discussing an idea or solving a problem.

The students' emphasis of the educational role of TMC entries provides a rationale for why students valued the mathematical content of what they wrote. This valuing was illustrated by students' effort and beliefs about writing coherent and main

ideas as well as how to solve mathematical problems. In distinguishing TMC entries from their individual journals, students reported that their individual journals mentioned general thoughts or "explained the whole thing," such as what the assignment was for the day, and rarely provided examples. In TMC entries, in contrast, they explained that they provided more details about what the class was doing for the day, a strategy for solving a problem, a couple examples or solutions, and an explanation for "what we did and how we go about it." They wrote more elaborate explanations of problems, a "step--by--step" process of how to solve them, and examples illustrating "how to do it" in TMC than in their individual journals. These themes from student interviews corroborate the finding that learners took initiative in including main ideas, strategies, solutions, and explanations in TMC entries.

These sentiments expressed in the interviews may explain why students demonstrated more effort in editing and modifying their entries in TMC environment than in nonpublishing activities. Attempting to polish the arguments they were trying to convey to the reader, students were compelled to discuss with their partners ways they could improve the wording and points they were trying to make. Learners perceived an audience for their Web entries other than themselves, but also imagined the educational role of their work in their own and others' learning. As a result, TMC entries were more likely to "go into more detail on the Web." Apparently, students' perception of an audience led them to provide more explicit journal entries to clarify ideas, strategies, solutions, and explanations.

In publishing, you can write something no one has. Ownership of work was another salient theme in student interviews that may illuminate why students took

initiative (see Appendix F for relevant responses). In addition to valuing the affordance of the Web to share publications with a remote audience, learners emphasized the importance of having the flexibility to write what they wanted to publish and to express ideas in their own words. Students were able "to write something no one else had [which] made publishing more interesting." Instead of having the "teacher tell [students] how to do it," students, themselves could "explain things" and write their "own ways" for doing mathematics.

Perhaps because students felt this ownership, they assumed authority over their ideas. This sense of ownership may have led students to take more pride in their work and more responsibility for what they wrote on TMC than in their individual journals. Although students could write their own thoughts in their individual journals, they believed the only people reading it were themselves, " the teacher, or Ms. Jones." The Web seemed to establish more ownership because "other people on the Internet" could read it. In this sense, their work was presented to the world--as students may bring something of their own to class for show and tell. They perceived TMC entries as their own publications for an outside audience. These assumptions also help to illuminate why students were so careful with the content of their Web journal entries and why they took initiative in elaborating the entries in the publications more than in their individual journals.

Design principle: audience. When I designed TMC, I envisioned an audience would lead students towards examining and re-examining their work to explain what they were learning and to teach others. In this study, students not only assumed an audience beyond the teacher (Cohen & Riel, 1989), but their perception of a public forum

(Lampert, 1987) resulted in greater efforts to publish sensible, educational journal entries on TMC. Aligned with my assumptions, students claimed that work presented on TMC was expected to teach others. However, a role of audience that I did not expect was that students considered the process of writing on TMC and the ability to use the publications as a reference as a ways to extend their own learning. They could learn new mathematics and clarify questions or problems they might have. Assuming that the audience for TMC included those in and outside the classroom as well as themselves, students believed that their publications could make an impact on the learning of an audience as well as of their own.

In addition, although students had individual notebooks for journal entries especially for themselves, they only emphasized a sense of ownership of knowledge (Brown et al., 1993; Songer, 1996) when describing their writing on TMC. Writing on the Web was an avenue to *present their way* of thinking to a public forum. With this perception of an audience, students tended to take initiative in creating a meaningful publication for others to use and read. Specifically, the efforts they made in TMC environment--the collaboration, management of tasks, and production of detailed entries--reflect students' action and ambition. In this sense, a perception of an audience was a key to fostering initiative.

When designing TMC, I anticipated that students might actually have an audience that would encourage student initiative. However, this study indicates that a *perception* or the *possibility* of an audience is very powerful in leading students to take initiative in carefully developing and revising their work or collaborating with others to create substantive publications. As a result, to encourage students to take more initiative,

teachers can take advantage of the Web's capabilities of making student work available to the world as a tool for creating a sense of audience.

Collaboration

You have someone else to help you. The role of working with their partners in engaging them in the publishing environment was also significant. Students expressed in their interviews that through collaboration, they could ask their partners for help and work together in completing TMC publications (see Appendix G for list of relevant responses). Indeed, while publishing, students collaborated on thinking of a topic for the entry, understanding ideas, solving problems, and deciding how to write the publication. "When [students] do it, it's a group thing, compromise,... teamwork," so they negotiated what to publish and worked together to "word it right" and develop a sensible publication. In addition, as knowledgeable others, partners could help students "get more stuff" to understand ideas. Through this interchange, students liked working with partners to solve problems, "to figure it out." "Sometimes kids don't do the work because they have to sit by themselves or do it by themselves and don't understand it." However, when students published, they had a "friend there to help solve the problem." Collaboration also afforded students the opportunity to discuss with others how to word entries or sensible mathematics that they "think everybody will understand."

While publishing, learners accomplished these goals through asking peers for help, continuing or editing publications, and challenging each other's ideas. In addition, perhaps because students were completing a collaborative product and seemed to take some ownership for the work, they delegated roles to divide the tasks and determine what

students could contribute to the publication. Since students each had a role in developing a collaborative product, students took more responsibility for requesting peer help, advising revisions, and challenging ideas. I suggest students developed a sense of accountability to the group, so took initiative in supporting each other and creating a quality publication.

Design principle: Collaboration. The second design principle, collaboration, indeed was another prominent factor that encouraged student initiative. A major premise of the role of collaboration was that students would encounter conflicts that would lead them to challenge each other or explain their thinking (Leikin & Zaslavsky, 1997; Yackel et al., 1991). While publishing, Mr. Watkins and I encouraged these kinds of interactions. We recommended that students turn to their partners with questions they had about their contributions or ask them for help on dilemmas they had in determining the topic or task and in solving a problem. The significance of collaboration was reflected in students' engagement in these kinds of interactions. While working together, students not only encountered conflicts they needed to resolve through explanations of ideas, strategies, and solutions, but also valued the importance of requesting and offering assistance.

Since students had an opportunity to collaborate, they were able to take initiative in resolving conflicts as I had projected. An important contribution of this work in defining the role of collaboration is that by having partners to consult, students took more initiative in *requesting* assistance: They had "a friend there to help them" in contrast to "being by yourself" with your individual journal and "not [knowing] what to put."

Therefore, this work indicates that students may not only offer their own thoughts, but also ask their peers for suggestions.

The Chain Linking the Themes: Norms and Practices

The chain linking these factors of audience, learning and teaching, ownership, and collaboration was the norms and practices established when students were introduced to the environment. Whole class discussion and incidental reminders of the norms and practices were given during the project. Main points of the norms and practices established were that:

- TMC was the students' own product,
- collaboration was expected,
- students needed to take initiative in generating arguments, explanations, strategies, and questions,
- learners needed to employ strategies to promote collaboration and initiative,
- TMC needed to represent the diversity of students' thinking, and
- students needed to consider the audience in deciding how and what to write.

I expected these norms and practices to set the expectations for how students should interact and that they, themselves, should take the initiative in developing their work.

Overall, students' interactions around TMC environment and the publications they created indicate that they were attuned to the norms and practices. Moreover, students emulated these norms and practices that ultimately led to their initiative in various domains. As anticipated, their ownership of the publications led to students' initiative in contributing ideas of how to revise and improve publications, but students

also discussed their value and emphasis on collaboration as a key factor for enhancing their interest and involvement in publishing. A common assertion students made was that they took more initiative by working with each other and by making an effort to develop a coherent, meaningful publication for "anyone on the Internet." In this sense, students highlighted the importance of working together and felt their contributions justified their authorship.

Students' initiative was also demonstrated as volition, willful action, and effort in including ideas, strategies, solutions, and explanations in their TMC work. As a result, norms and practices indeed seemed to frame the kinds of publications students wrote on TMC. Finally, a perception of an audience seemed to be the most highlighted difference of TMC and the reason why students took initiative. Students' serious consideration of a possible audience was reflected in their emphasis on teaching, learning, and ownership and explains why they took initiative in developing carefully written, sensible TMC entries.

This work reinforces the premise that a context has its' own norms and practices (Green et al., 1996) that creates the boundary for how students perceive a situation and interact in the environment. In addition, it suggests that educators can design environments based on norms and practices to promote particular kinds of learning experiences (Brown et al., 1993). This work provides, however, only one interpretation of how to weave design principles into an environment with the goal of promoting initiative.

Summary

Students demonstrated initiative in different ways and the kinds of initiative varied across contexts. Final interviews with students provided the underlying rationale for why they took initiative and revealed how TMC environment supported students' actions in mathematics learning. Whereas analyses of observations and journals represented the manifestations of initiative, students' interviews illuminated what principles educators should consider in fostering initiative. In TMC environment, audience, teaching, learning, ownership, and collaboration were central themes highlighted in students' interviews that seemed to be the catalyst for initiative. The significance of these themes is that they reflect the design principles used as the framework for engineering TMC environment indicating that educators can be innovative in developing an environment to promote initiative.

CHAPTER 7

CONCLUSIONS

Currently, one of the greatest challenges of educators is to develop techniques for capturing the interest of learners and motivate them to actively participate and navigate their own learning. This study offers new insights into the issue of initiative by providing one example of a Web-based technology, TMC, that illustrates how an environment based on design principles may be used to foster initiative. The nature of the Web environment allows for a perceived audience because publications to the Web are viewable to anyone who has access. This perception of an audience was powerful in students' feelings of ownership, learning, teaching, and collaboration. With the belief that a student "in another school," someone at home, or people "from all over the world" could view their work, students could display their own ways of doing mathematics, could learn from the work as well as teach others, and help each other in developing or revising work. Results from this study indicate that a Web-based environment may be a powerful tool in promoting the perception of an audience and that this sense of an audience could be a very important factor enhancing students' initiative.

Implications

This research contributes to a better understanding of how initiative is taken, but more importantly, a practical benefit of this work is that it provides some ideas for how educators can foster it. As suggested in this study, educators can establish norms and practices that cultivate student initiative. Students can assume roles and become

acculturated to norms and practices through which students take initiative in their learning.

In addition, the role of tools is interpreted and manifested through students' use of them. This study of TMC provides insight into what aspects of an interactive Web-based environment can be used to support initiative and how students perceive this tool in their own and others' learning. A perception of an audience seems to be a significant factor of a Web-based environment. This work contributes to a wider body of research focusing on how the Web can be a partner to educators in fostering initiative and implies that they should capitalize on the perception of an audience created by Web-based publishing.

On one level, this research advances the understanding of initiative, but ultimately contributes to the broader issue of promoting learners who develop their own thinking (National Research Council, 1989). By nurturing learners who take initiative, we are educating our students to take authority over new problems they might encounter. In the workplace and community, we expect people to take it upon themselves to be resourceful and innovative in their thinking to accomplish tasks and solve problems. Likewise, we should expect students to emulate the same kind of responsibility in their own learning to acculturate them to these kinds of environments.

Limitations and Future Directions

An examination of initiative in this study only begins the journey toward deconstructing this phenomenon. Students' perceptions of and interactions in TMC environment compared to nonpublishing activities were explored. However, more investigations into students' perceptions of other activities paired with analyses of more

observations of students across varying contexts can help isolate features that might foster initiative.

Students in this classroom were not able to write in TMC environment regularly throughout this study because there were only two computers in the classroom. It is difficult, therefore, to conclude that TMC made an impact on student initiative because students had limited experience in this environment. I do not attempt to make this claim, but suggest that this research provides a window into understanding what initiative may look like and the factors that may support the different types of initiative. This intervention may have been a small part of the classroom, but given that this was an urban school with few technological resources, the experiences students had with TMC were unusual. As students expressed, TMC was different from other mathematical activities in the classroom. Although TMC may not have reengineered the norms in the overall classroom, it was a microenvironment in the classroom that resulted in different experiences and interactions than other activities.

In addition, it seems students emulated the norms and practices that were established during the introductory phases of TMC environment. Future research that includes interviews and observations of students before the presentation of this kind of environment might reveal whether students' emulation of norms and practices indeed resulted from preconceived notions about the environment or from the norms and practices established.

Whereas this study focused on what kinds of initiative students may take in the publishing environment and the factors that may foster them, it did not address whether TMC environment enhanced students' initiative over the year. Since students did not

have as many experiences publishing on the Web as they had in other activities in the classroom, it is questionable whether TMC had any impact in enhancing students' initiative over the year. Future work tracing the development of students' initiative may reveal whether the amount of experiences students have publishing influences the amount of initiative students take.

The Impact of TMC in Mr. Watkins' Classroom

After the year ended and a new one began, Mr. Watkins and I sat in his new classroom waiting for his next class to begin. We returned to the previous year and remembered the role TMC had in the classroom. Mr. Watkins held his goal of developing learners who took more control of their learning by taking initiative in their mathematics thinking and problem-solving. He recalled that students' interactions around TMC were different from when they were participating in other activities. When observing students himself, he noticed they took a "different perspective, a different approach" when they published on TMC. "They were more reflective, more careful with the words they chose--not as much verbiage as when they wrote in their individual journals."

TMC seemed to hook in some of the students. They were "excited to write on the Web" and tried to "incorporate ideas from discussions." Others, however, seemed so engrossed in the work that it seemed difficult for them to also engage in the discussion. As a result, pedagogically incorporating TMC himself as he tries to orchestrate the many other tasks as a teacher is a puzzle. Mr. Watkins is very interested in using TMC and managing the environment himself despite this struggle. He thinks it is a "creative way to

get them to do out of the ordinary doldrums that forces some students to think about mathematics differently and in a concise way." More importantly, it "blends in well with what we are doing in the classroom with the CMP." In this sense, Mr. Watkins values the role of TMC in mathematics learning and wants to employ this tool as a way to get the students to take more initiative by hooking in his students and getting them to take more action in their learning. Mr. Watkins' sentiments illustrate that he believed TMC changed the way students interacted in their learning and has potential in shaping other students' initiative. Along these lines, fostering students' initiative continues to be an issue affecting Mr. Watkins' pedagogical decisions in his new classrooms.

APPENDICES

APPENDIX A

INTERVIEW PROTOCOL

Topic: What is the journal all about?

1. Do you think that publishing journals on the web is different from writing in your math journals? How?
2. Do you think what you write is different? How?
3. Would you rather write in your journal or on the web? Why?
4. You know how we have a new student in this class, Josh (or one of your friends)? How would you explain what the web journal is all about to him or her?
5. What is the purpose?
6. What are important things to remember while publishing? Things that you shouldn't do?

Topic: Do they like publishing/is it motivating?

7. Now, I am going to ask you about how you like publishing or how you find it interesting whether you like publishing or find it interesting. So, what do you think about publishing?
8. How do you like publishing compared to other activities? Why/ why not?
9. Do you think publishing is different from other activities that we do in class (makes it fun)? How?
   Next year, we are thinking about having publishing but trying to understand whether we should have it. Do you think we should have it? Why should I have publishing? or what is it about publishing that you like?
   How is it fun? What makes it fun?
10. Do you think that publishing on the web leads you to do math or makes you want to do math more? Why?
11. Have you read other people's work on the web journal? Have you published before? Have you done journals before in math classes?

APPENDIX B

CHRONOLOGICAL ORDER OF STUDENT RESPONSES

Case	Responses
Jake	[Writing on the web journal is different from writing in the individual journals] because everybody can read it. You write all the steps and stuff. You tell the solution strategy. In the journal, you just write what you did that day and an example.
	[I'd rather publish on the web than write in my journal] because you get to review it while you are typing it.
	Every once in awhile someone gets chosen to go and write about what we're doing in class, you can choose a subject. Like, how to find the sums of adding fractions and publish what you wrote.
	[The purpose is] to share what you're learning with people who are reading it.
	Shouldn't tell them the wrong way to do a problem. Remember that everybody is going to read it. Make sure you have the right answer before typing it up. You shouldn't publish the wrong answer or the wrong way to write it.
	I think publishing is neat because we get to share ideas with others outside this school.
	I would rather publish than take a test or would publish and do the worksheets at home.
	[Publishing is different from other activities] because you are using a computer and sharing it with everybody else, whoever looks at the Internet, share what you did in class.
	It makes learning math more interesting because you get to type on the computer and write about what you are doing in class.
	[Publishing is different from other activities,] like with worksheets, you have to do that alone, but with publishing you get to go up and work with a partner.
	[It would be different if Mr. W. told you to write something instead of writing your own,] because when you publish you can write something no one else has. This makes it more interesting.
	Because you are using the computer, sharing your ideas.
	AH and I went on and saw what people published during the last time
	[never published before]
	[never written in journals before]

APPENDIX B (cont'd)

Case	Responses
Jeff	[The web journal is sort of different from my journal] because I write more in my journal, but not as long. But it might be the same because I don't write much in my journal, either.
	Sometimes [what I write in my journal is different from the web] because it's more for myself, so you only have to explain it so you understand. [In the web journal,] you have to write it so everybody can understand it.
	It doesn't really matter [if I publish or write in my journal].
	[The purpose is] so other people know how to do it or know what you are talking about.
	[In publishing, you need] to do it step by step. Like if you can say that these all go together, you have to say 2 and 2/5 plus this is what. Instead of just writing down what everything is altogether, go step by step and tell what you are doing. you should go step by step and add it together. Make sure you are spelling it right and double check the answer to make sure you know it is right.
	It's fun, but sometimes it takes away from class. It's hard to type and pay attention at the same time.
	Yeah, [I'd rather publish than do other math activities] because I don't like doing the other things in math class. It's fun.
	[Publishing is different from other math activities] because you get to use the computer, you get to put what you say, so everyone in the entire world can read it. You can put it in your own words, but you have to make sure other people can understand it.
	Sometimes I want to publish and sometimes not. If we are having class discussion, I'd rather publish. Sometimes I'd rather publish, like when I'm tired.
	[If the teacher picked what you had to write about instead of letting you pick want you wanted to write,] I don't think it would be done as well. If you publish about what you want to publish, then you know what you are going to say, and if you have to publish what you want us to publish, you have to figure out what you are going to say and how to figure it out instead of what we already had planned for it or what was already in our journal.
	It [publishing] is different from how we did math because we used to just have the blackboard and no journals. It makes it a little more interesting and different because you get to work with someone else and both of the people are trying to figure it out. I like that better.
	[Although I can do small group work during other math activities,] I'd rather publish because I like it better.
	[has not seen what others done] [has not published] [has not done journals]

APPENDIX B (cont'd)

Case	Responses
Lynton	[Publishing is] more fun because you get to type on the computer, you are on the Internet and put what you want to publish.
	Yeah, I'd rather write on the web because it isn't right in front of you and the web is not like that. I can't explain why.
	It's fun because you get to type and pick what you want to write about.
	The purpose is to explain to other people what you are doing. Like, people can click on Otto and see what we're doing.
	You could do whatever homework you did and explain how you did it. Like your homework, you can scan it through and write what goes with it and you can cut out stuff that doesn't. You shouldn't mess around or scan stuff that shouldn't be scanned.
	Yeah [the things I write on the web are different from what I write in my journal], because you can write how you got your answer and ask questions like, do you get it and stuff. You can be the teacher on the web. When it's just in your journal, you can't do that kind of stuff because the teacher is just reading it.
	It's fun. I think that you should have it next year to help out the kids because this has helped me a lot in understanding the computer and math because I was a bad student. I'm surprised I got into enriched math. When I explain it on the computer, I know exactly what I am saying. That helps me out with my math. When we have partners, like smart people helping us, you get it because once you read it, you say, oh, now I get it.
	[Working with others during publishing is not really different from working others in other activities.] When you work with other people on other stuff, it's easier because you get more stuff. It's harder when you work by yourself because you don't get the stuff.
	Yeah, it's funner because of typing and looking through the stuff like what you wrote. Like when you go through the stuff and see what goes with the stuff. It's fun going through and seeing what other people wrote. And you have a password so you can put in your own thing.
	Publishing is like doing math, but doing it on the computer and writing it out instead of just reading it and doing it. You are writing it out. I think it would be more boring if you just did your own journals because, on the web, you get to work with a partner. When you look at other people's work, you can cut out the stuff that doesn't go with it. If they put, 'oh, I forgot to mention I got an A.' You can cut that out because that has nothing to do with it.

APPENDIX B (cont'd)

Case	Responses
Lynton	Once you do your math more, you get to publish more. If you don't do your math, you can't publish because you don't have anything.
	Yeah [I've seen other people's work.] I corrected some of it. Responding in class.
	[has not published]
	[has not done journals]

Case	Responses
Ganton	No, well, I like the web better. You don't have to have a pencil, so you can just publish.
	No, [the things I write in my journal] is not really [different from on the web].
	It's [Publishing is] like notes. At the end of the day, you just have to write down what you did.
	If you are stuck on something, you can go and look back. If you forget how to do something you can look back on your notes. It could tell the teacher if you are paying attention in class or not.
	If you find something interesting, you can publish it.
	The purpose is so that other people in other schools can see what you are doing.
	Don't write stupid stuff or things you don't know what you are talking about. You should write about stuff you know about.
	If you don't have a pencil, you don't have to write everything down. I like looking at other people's journals, what other people have been putting on there and see if I want to put a response.
	With other stuff, all you got to do is work. This is fun, though. ...On the web, you don't have to do tests or other assignments. You just got to write down one example problem and tell what it is about.
	Yeah, it would be different [if you told us to type on a specific topic instead of letting us choose our own] because the stuff that you want to type, you'll know and the stuff you want us to type, we might not know about.
	Yeah, because if you don't know what you are doing, you'll just be sitting there writing about something you don't know. If you don't know what you are going to do right then, you can think of something.
	If you are publishing and others are doing the classwork, the publishers usually have to do it at home and turn it in. I don't mind because you have all night to do. I'd rather publish and do that at home. Except when I don't know what we are doing covering in class.
	Yeah, [I've seen what others have written.] When I go on sometimes, me and my partner make reflections on people's work.
	[has not published]
	[has done journals] in 5th grade about the assignment done

APPENDIX B (cont'd)

Case	Responses
Tara	[The web is different] because it is more fun to write on the computer. [I'd rather publish on the web] because on the web, other people can see your work.
	We explain more on the web than in our journals. On the web, we explain and do step by step how to do one problem and in our journals, we explain the whole thing. We explain what we did and how we go about it. We pick one problem and explain it step by step. In our journals, we explain the whole thing. Like what we did and some examples of what we did. On the web, we'd explain how do the problem.
	You pick something, people and they publish it so other people can look at it.... To help other people on the Internet learn.
	To stay on task, to listen to Mr. Watkins too while publishing. You shouldn't talk about other things beside our assignment, not listen to Mr. Watkins.
	I like publishing. It's fun. It's more fun than other activities. When you publish on the computer, it's just more fun than sitting and doing your assignment.
	When you are publishing on the computer, you give other people chances to learn, other people on the Internet.
	When you are publishing, you are talking about math problems, and it just makes you want to do math more.
	When you are publishing, it's just more fun then sitting down and doing a class assignment because you get to be on the computer.
	No, [it isn't the same if students just wrote their journal on the computer and not the web] because on the web, other people can see what you do and it can help them more. [This is an important] because other people need to learn too.
	[has not seen what others have published]
	[has not published]
	[has not done journals]

APPENDIX B (cont'd)

Case	Responses
Ande	Yeah, [the web is different from my journal] because when you are on the computer, you talk about how you do it and how you get the answer, but in your journal, you write what did you do in class. Like, in class we did 3/4 and 1/5 and we learned how to do times. On the web, it's about the same thing, but you talk to other people and tell them how to do it.
	[I'd rather publish than write in my journal because] of typing, telling how to do it, and publishing.
	No, [I don't think what I write on the web is that different from what is in my journal.]
	You have to explain what you did in class and a solution for how to do it and give them a couple of examples.
	[The purpose is] to remember things and if someone else published and you didn't understand something, you can go to their publication and read it and understand it.
	[You need to remember] how to do it. Before you publish, you have to know what you are explaining and how to do it. You know what to do when you get on there and how to explain your answers. You shouldn't play around on it.
	I think it's a good way to learn how to do different things and learn how to, for example, if you didn't know how to do something, you can go back and learn all different kinds of things. If you didn't know how to do something and somebody published it and you were looking around on the computer and found something you didn't know how to do and you read it and they explained it really carefully, you can learn how to do it.
	Yeah, it's fun because it's like telling people how to do other things they don't know how to do.
	Publishing is different because with a worksheet, you just put down the answer, but with the publishing you have to explain your answer, how you got it. It's better to explain your answer than just right down the answer because if you get the answer from somebody, you can't explain it. But if you publish, you have to explain it.
	Publishing helps other people and gives you a chance to do other things you don't know how to do. If you publish and let everybody see it, you feel happy because you taught somebody how to do something that they didn't know how to do. If you didn't have publishing, most people couldn't learn as much stuff because they couldn't look through and see if anybody has put anything they did not know.

APPENDIX B (cont'd)

Case	Responses
Ande	Yeah [I'd rather publish than do other activities.] Both of them help you understand how to do it, but publishing is funner.
	No, [publishing does not make me want to do math more], not that much.
	[has done responses with AH]
	[has not published]
	[has done journals] in 5th grade discussing how long we spent in class and what we did. In an hour's worth, we did a sheet and it had this on it.

APPENDIX B (cont'd)

Case	Responses
Mandy	[Publishing is sort of different from writing in the individual journals] because when you publish in your journal it's just for you, but when you publish on the Internet, it's for everybody else.
	[I'd rather publish] on the web [than write in my journal] because it helps other kids learn new things and it's fun typing.
	No, [the web journal and my journal is not different.] I write things like strategies and problems I am doing.
	[Publishing is] like you explain things, explain problems, how to do special techniques, and easy ways to do things, and you just write it, just type it on.
	[The purpose is] to help other people and let kids know what you are doing at your school.
	Make sure other people can understand it, make sure it makes sense. You shouldn't do bad things, like English when it is about math and something that doesn't make sense.
	Publishing makes sense for people to do it, not like all those things that the teacher makes you have to do. It's something people want to do... because it is fun and if you are going to help someone else and if other people are going to help you. If there is someone else in another city trying to do a problem, I can write this down and try to help them if they have a problem with it.
	I think kids would rather publish than do other things in class. It's different because it let's you explain things instead of letting the teacher tell you how to do it. You can put how you think is easy to do it your own way.
	Yeah, [publishing does make me want to do math more] because when I publish I start writing something and think, oh my gosh, it does really work and start using it.
	[has done journal writing, but just put problems in it.]
	[has not seen other entries]
	[has not published]

APPENDIX B (cont'd)

Case	Responses
Camrn	Yeah, [the web journal and my journal are different] because in the math journal, the only people who see it are you (Jones) and Mr. Watkins, but on the web, other kids who are having problems or whatever, they can look on our sheet.
	[I'd rather publish] on the web [than write in my journal] because I don't really write in my journal. I don't really know what to put in there, but on the web, there's somebody else who can help you word it right or whatever when we are publishing.
	[What you write on the web and in your own journal is] a little bit of the same thing because you have to put examples and what you did in class.
	I would tell him that you organize it so that we have different partner and that when you publish, you just pay attention to what's going on in class and on the computer, you can type it down on the computer and it will go through. You still have to type examples and how you got the answer or like a problem you are doing or checking over.
	[The purpose is] to help other kids, like maybe in the X school district or all over, to help them if they don't know or if they are doing the same thing or if they want to see how other people are doing it.
	Remember your problem, and how you got it, what strategies did you use. You shouldn't put the whole problem, but just part of the problem, and the examples. You could put down your answer and how you got it.
	Publishing is fun because in your journal, when you are by yourself, you might not be able to think of what to publish, but when you have a partner, you can ask them how to word it right or help you.
	Yeah I like publishing, sometimes in class, it is boring, but when you get to publish, you can write down what you think about it, how you got the problem.
	It's different [from other math activities] because, in our classroom, the only people who get to see what you are doing is in your class, but when you publish, other kids get to see it too.
	When you publish, you are not by yourself, and sometimes kids don't do the work because they have to sit by themselves or do it by themselves and don't understand it. But when you are publishing and you put down a problem, you have a friend there who can help you solve the problem or a friend who can help you think of a problem to put down. It is also fun because it lets you show other kids, not just those you are working with, it shows other kids.
	No, it's not that different [from publishing if you get to work with other people in another activity.] It don't make any difference because you still have kids helping you.

APPENDIX B (cont'd)

Case	Responses
Camrn	Yeah, [it makes me want to math more] because if other kids like it from wherever, then your teacher might like it too. If you are with your partner and doing a problem and they like it too, the teacher might like it too.
	[Publishing], it's fun because it gives you a chance to explain to other kids, how to do a problem or how you got the answer or examples of what you did.
	[has not done journal writing.]
	[has not published before]
	[has not read other people's work.]

APPENDIX B (cont'd)

Case	Responses
Tinse	[Publishing is] not really [different from writing in your journal] because it is just writing on the computer instead of the paper.
	[I'd rather publish] on the web [than write in my journal] because it is more fun typing than writing it down.
	When you publish, you write what you learned from one of the lessons and show how you did it.
	[The purpose is] so that other people can see what you learned and what you do in math class.
	Don't put your name. Make sure the sentences are right and not irregular sentences and make sure what you wrote is right and like how most people do it and not wrong.
	No, [what I write in my journal is not different from what I write on the web.] Things I write are what you should learn and strategies you use. Sometimes, I forget to do it in my journal.
	It's interesting to see how other people learn math instead of only the way you learn.
	Yeah, I'd rather publish than other math activities] because others are boring. You get to work with the computers in publishing.
	I like publishing on the web [versus just writing on the computer] better because other people can see what you wrote. If you just typed it on something, not everybody would see it.
	Publishing is different because you use computers and in other activities we don't use the computer as much.
	Yeah, because other people can learn how you learn and it's fun.
	Not really, [publishing doesn't make me want to do math more.]
	[has not done journal writing.]
	[has not published before.]
	[has read and responded to other people's work during publishing.]

APPENDIX B (cont'd)

Case	Responses
Abraham	Yeah [publishing the journal on the web is different from writing in the individual journals], because everybody else can see it and they don't have to ask you. They can just get on and see it.
	[I'd rather write] on the web [than in my journal] because it helps with your typing skills and also other people get to see it from all over.
	[What I write in my journal is] not really [different from what I write on the web.] I write different problems, different solution strategies.
	I'd say just write what you did in class on the journal, like a problem we did today. Solution strategy that he learned from Mr. Watkins.
	[The purpose is] so that other people, in smaller grades can see what we're doing if they haven't learned it yet, or older people to see what they are doing.
	Everybody can see it, your audience you are writing to. Use proper spelling, punctuation, all the editing stuff and make sure your information is correct. If it isn't, everybody is going to get messed up.
	Shouldn't type something off your brain, something you think you learned at home from your book, something you haven't talked about yet, something you don't know totally about yet.
	I think publishing is interesting. Sometimes, I get on the computer at my grandmother's house and get on to see what other people are doing.
	Yeah, [publishing is interesting] because you get to work with other students that you know. You get to type and work together and to publish something that everyone can see, that is bigger than just in the classroom, so everybody that has a computer can see it too.
	Publishing is different because you use computers, you write solution strategies, not just talk about them, so you can remember them. It's not just problems, but solution strategies, ways to solve stuff and you can make up your own problems, too.
	Yeah, [publishing is interesting] because you can work others and talk about what you think is correct and what you should write on there, whatever you think everybody will understand.
	Yeah, [it makes me want to do math more] because you want to learn stuff. When others login, they can see your initials and decide to read yours. They can learn from them. I think it's cool. I get to see other solution strategies and I get more involved in math because I learn more stuff everyday. And I get to write more stuff. After I type stuff, I want to learn more about that subject and publish more on that subject.

APPENDIX B (cont'd)

Case	Responses
Abraham	[has done journal writing]: multiplication tables. If she talked about an idea, we had to copy it down, so then she would say look back your journal and use the solution strategies I told you to use yesterday.
	He thinks his journal is different. The web is longer, has different ideas, different vocabulary.
	[has not published before]

APPENDIX B (cont'd)

Case	Responses
Bali	Yeah, [the web journal is different from writing in you own journal] because when you write in your journal, it is really boring. When you write on the screen, it is fun because you can type. There is a delete button, so if you make a mistake, you can change it, but if you use your pencil.... You can delete mistakes more easily.
	I'd rather write on the web because it is kind of fast and more fun because you get to see interesting things and see new stuff. With pen and pencil, you get used to it and gets boring.
	No, [what I write on the web is not different from what I write in my journal]. I think it is pretty much the same, just faster on the computer. [I publish things about] fractions, decimals, things like that. One time, I put that it was really cold in here, but would not write that in the web journal. On the web journal, I would write something like I was doing fractions and decimals and stuff came up with this problem, give the answer and how I got it.
	I'd tell him that it's like writing in your own journal. Just think of something and type it, then ask you [Jones] if it is alright. You would put things we are doing in class.
	To not forget it, have it there and other people can read it. Be serious about it. Pay attention in class before you publish, so you know what we are talking about that day. You shouldn't mess around with the computer and try to focus on class.
	I think it's interesting because it's a new place to explore. On the web, you can go back and say that's really cool, and that's really cool and I've never seen that before.
	I think it's funner than just sitting in class and just paying attention to Mr. W.
	Yeah publishing is different. If you are just sitting there listening to Mr. Watkins, it gets boring, but publishing is fun.
	Yeah [I think you should have publishing next year.] I think it is interesting because it gives kids a break from Mr. W. talking and it is a new thing to learn.
	She doesn't read what people publish.

APPENDIX B (cont'd)

Case	Responses
Bali	No, I think it is a more interesting way of taking a break. Instead of saying that you are going to put down your pencil and take a break, you can just go to the computer and take a break while you are working.
	[has not done journal writing.]
	[has not published before.]
	Just typing and trying to pay attention to Mr. W. at the same time, so we can still get a good participation grade and still have some fun on the computer.

APPENDIX B (cont'd)

Case	Responses
Shanon	Sometimes, [the web journal is different from your own journals] because you have to explain it better on the Internet. People won't understand what you are saying. You have to make it more clear so they can understand it.
	Either one's fine. I like to do them both [writing on the web and in my own journal].
	[What I write in my journal and on the web is] basically the same. I write if the problem was hard or if I have to remember something to do it better later. I write it down, so I can remember it.
	On the web, you have to explain to other people what you are doing and how the problems work.
	[The purpose is] so that other people can see what we are doing and they can learn some stuff too.
	You have to explain it really well like how you do the problem, how you get the answer, what to do. You shouldn't write something you don't explain at all and you should try it on somebody else to see if they understand it, so then other people will probably understand it too.
	[Publishing is] fun because you get to show other people what you are doing, and so they can understand it too.
	It doesn't matter [whether I publish or do other math activities] because I usually publish what I do in math class.
	Yeah , [other math activities are different] like with the overhead, we draw graphs and shades things in, and we don't do that in publishing.
	She doesn't read what people publish.
	Yeah, [publishing makes me want to do math more] because it's easier to explain and you'll be able to explain more stuff.
	[has not done journal writing.]
	[has not published before.]

APPENDIX B (cont'd)

Case	Responses
Lin	Yeah, [the web journal is different from writing in your own journal] because other people can read them not just teachers, and they can login from home to read it.
	[I'd rather publish] on the web [than in my journal] because it is fun to type and to have people see your ideas.
	[What I write in my journal is] a little bit [different than what I write on the web] because you show what you've done, but you do the same thing in your journals, so it's not that very much different.
	You write what you did in class and how to do it, the instructions to do that paper or problem and write down the ideas.
	[The purpose is] so that people can see what you did in class.
	Remember to title your paper and tell what you are doing, to show it and don't just put some answers down. Make sure you show how to do it....Don't just put the answers, but make sure you tell what the questions are and what you did.
	I think it's [publishing] fun because you get to write on the computer, put your ideas, and what you did in class. It's nice to let people know what you did in class.
	Yeah, [I'd rather publish than do other math activities] because you have to do other activities , but you get to sit there, learn how to use the computer, write about stuff you did in class, instead of just write down things on paper.
	[Other math activities are] sort of [the same as publishing] because you write down what you did down in class, so it is sort of the same, but you don't just do it, you write about what you did.
	Yeah, I'll read others and write down responses. I've read what they've put and put a response. I've done that a couple of times. I did it at home, but it didn't work very well because my brother wanted to get on and I didn't get to finish it.
	Yeah, [publishing makes me want to do math more] because it is fun. You get to learn more about what you are doing that way. That makes you understand it more. Once you think about it more to write it down, it makes you understand the problem more.

APPENDIX B (cont'd)

Case	Responses
Lin	[has done journal writing, but it was just problems and the answers.]
	[has not published before.]
	Yeah, [publishing makes me want to do math more] because if you don't do the homework, you won't be able to do that because you don't know what you are doing, so it helps the kids because it is fun to do that, so they get to do that, so they should do the homework. It makes them think I better do this if I want to write on the computer tomorrow.

APPENDIX B (cont'd)

Case	Responses
Hazel	Yeah, [the web journal is different from your own journal] because you share your ideas when it's on the web and more people can see what you are doing in class.
	[Compared to writing on my journal, I'd rather publish] on the web because it just gives you a chance to show your ideas and thoughts.
	[What I write on the web is] not really [different from what I write in my journal] because when if I write something in my journal, I usually write that on the web.
	The web journal is a web site on the computer, you log into and have your own password and you publish things you did in class, things that you talk about in school.
	[The purpose] I think is to share your ideas. People respond to it. It's not really bad if they respond to it because you know that they are reading your stuff and listening to what you have to say.
	Write in what you talked about in class. You should reread it to make sure you put what you wanted to say. Just fill out all the information on the screen. Things you talk about in school or you can have your paper scanned. Don't use foul language and don't put your full name.
	Yeah, [publishing is interesting.] When you do it, its a group thing, compromise and think of something to put on. It's just teamwork when you put it on there.
	If it's just dittos, I don't mind, but like tests, I'd rather publish. It's just fun. I don't really know why, but I just like doing it.
	[Publishing is] not really [different from what you do in other math activities.] You just talk about what you are doing. When you publish, you talk about the ditto sheet or what you did in class today.
	I don't know [why publishing is fun]. I think it is that you just basically get to work with your friends.
	It doesn't really matter [whether I do other activities that allow me to work my partner.] I just like hanging out with her, and we usually work on things together.
	Yeah, sometimes, if I am in science, I think about things I would put on the web. Usually the class after because I think about that I could have put that on before instead of this or something... or what I may want to do.
	[has not published before]
	[has not written in journals before]
	[has read others and responded]

APPENDIX B (cont'd)

Case	Responses
Justin	I think [publishing on the web is different from writing in your journal] because when you get an experience with typing and working on the computer. It's more fun. You get to learn how to publish things and it's more exciting. We can look at it from home and look over it. It seems better than doing it than with paper and pencil.
	[I'd rather write] on the web [than write in my journal.]
	I think [what I write in my journal is different from what I write on the web] because I always make things longer when I type so I can explain it better than when I do it in my journal because I know what I'm talking about in my journal.
	First of all, you have to learn the stuff, then type all that you know about it... all the stuff we've been learning in class.
	The purpose is to let other people know what we are doing in class.
	Just type all that you know about the subject. You shouldn't do anything else you weren't told to do, just do what you were supposed to do and not anything else. Like don't mess with things, just type your publication.
	I think publishing is interesting because this is the only class you get to do this kind of stuff, like typing your journals, type what you know about what you did in a certain area.
	I'd rather publish than any other subject in school except for gym and in math. It's fun typing in publishing. On the other hand, you don't get to do the other stuff. You don't get to learn the other stuff when you are typing.
	I think publishing is different from other activities. Usually in other activities, you don't get to type, you just write problems. Here you can explain why you put something down, why or how you came up with the answer.
	You miss out on the other stuff sometimes. It's just fun doing things on the computer.
	It wouldn't always make a difference [whether I was just writing on the computer versus publishing on the web]. Well, I like publishing on the web a lot. You get to tell other people your opinions and they listen to it.
	[He's read entries from home.]
	Yeah, [publishing makes you want to do math more because] it makes you want to get to math class or for first class because you are eager to do it.
	[has not published before]
	[has not done journals before]

APPENDIX B (cont'd)

Case	Responses
Kyndi	It's different because. Well, it's the same. I write about like what we did in class, homework assignments in my journal, well, I don't write homework assignments on the web. It's sort of both, same and different.
	Publishing is interesting because kids that don't know how to do things get a chance to learn about computers, not only computers, but the Internet. People respond to their journals and may get better ideas of what they have been doing. For example, I put a math problem, an example on the Internet and Shanon corrected it because I made a couple of mistakes.
	Yeah, [what I write in my journal is different than what I write on the web.] You go into more detail on the web. People explain it better so other people can understand it.
	[I'd rather publish] on the web [than write in my journal] because I like it better. I like using computers.
	[What I write in my journal is] not really [different from what I write on the web.] It has the same kind of main idea.
	You just write about investigations you do and explain it to people like how you got your answer and what you are doing in school.
	The purpose is so that people can see what you are learning and so other people can learn.
	Make sure that people can understand what you write and choose your words carefully. Don't go to other web pages while publishing.
	At first, it's kind of interesting, but it gets boring after a little bit.
	I probably like the other things [math activities] better. I don't know why, I just do.
	has read what others have published and responded
	No [publishing does not make me want to do math more.]
	[has not done journals before]
	[has not published before]

APPENDIX C

RESPONSES ACCORDING TO QUESTIONS

Question 1: Do you think that publishing journals on the web is different from writing in your math journals? How?

1.	[Writing on the web journal is different from writing in the individual journals] because *everybody can read it.* You write all the steps and stuff. You tell the solution strategy. In the journal, you just write what you did that day and an example.
2.	[The web journal is sort of different from my journal] because I write more in my journal, but not as long. But it might be the same because I don't write much in my journal, either.
3.	[Publishing is] more fun because you get to type on the computer, you are on the Internet and put what you want to publish.
4.	Yeah, [the web is different from my journal] because when you are on the computer, you talk about how you do it and how you get the answer, but in your journal, you write what did you do in class. Like, in class we did 3/4 and 1/5 and we learned how to do times. On the web, it's about the same thing, but you talk to other people and tell them how to do it.
5.	[Publishing is sort of different from writing in the individual journals] because when you publish in your journal it's just for you, but when you publish on the Internet, it's for everybody else.
6.	Yeah, [the web journal and my journal are different] because in the math journal, the only people who see it are you (Jones) and Mr. Watkins, but on the web, other kids who are having problems or whatever, they can look on our sheet.
7.	[Publishing is] not really [different from writing in your journal] because it is just writing on the computer instead of the paper.
8.	Yeah [publishing the journal on the web is different from writing in the individual journals], because everybody else can see it and they don't have to ask you. They can just get on and see it.
9.	Yeah, [the web journal is different from writing in you own journal] because when you write in your journal, it is really boring. When you write on the screen, it is fun because you can type. There is a delete button, so if you make a mistake, you can change it, but if you use your pencil.... You can delete mistakes more easily.
10.	Sometimes, [the web journal is different from your own journals] because you have to explain it better on the Internet. People won't understand what you are saying. You have to make it more clear so they can understand it.

11. Yeah, [the web journal is different from writing in your own journal] because other people can read them not just teachers, and they can login from home to read it.
12. Yeah, [the web journal is different from your own journal] because you share your ideas when it's on the web and more people can see what you are doing in class.
13. I think [publishing on the web is different from writing in your journal] because when you get an experience with typing and working on the computer. It's more fun. You get to learn how to publish things and it's more exciting. We can look at it from home and look over it. It seems better than doing it than with paper and pencil.
14. It's different because. Well, it's the same. I write about like what we did in class, homework assignments in my journal, well, I don't write homework assignments on the web. It's sort of both, same and different.
15. Yeah, [what I write in my journal is different than what I write on the web.] You go into more detail on the web. People explain it better so other people can understand it.

Question 2: Do you think what you write is different on the Web versus what you write in your individual journal? How?

1.	Sometimes [what I write in my journal is different from the web] because it's more for myself, so you only have to explain it so you understand. [In the web journal,] you have to write it so everybody can understand it.
2.	Yeah [the things I write on the web are different from what I write in my journal], because you can write how you got your answer and ask questions like, do you get it and stuff. You can be the teacher on the web. When it's just in your journal, you can't do that kind of stuff because the teacher is just reading it.
3.	No, [the things I write in my journal] is not really [different from on the web].
4.	We explain more on the web than in our journals. On the web, we explain and do step by step how to do one problem and in our journals, we explain the whole thing. We explain what we did and how we go about it. We pick one problem and explain it step by step. In our journals, we explain the whole thing. Like what we did and some examples of what we did. On the web, we'd explain how do the problem.
5.	No, [I don't think what I write on the web is that different from what is in my journal.]
6.	No, [the web journal and my journal is not different.] I write things like strategies and problems I am doing.
7.	[What you write on the web and in your own journal is] a little bit of the same thing because you have to put examples and what you did in class.
8.	No, [what I write in my journal is not different from what I write on the web.] Things I write are what you should learn and strategies you use. Sometimes, I forget to do it in my journal.
9.	[What I write in my journal is] not really [different from what I write on the web.] I write different problems, different solution strategies.
10.	He thinks his journal is different. The web is longer, has different ideas, different vocabulary.
11.	No, [what I write on the web is not different from what I write in my journal]. I think it is pretty much the same, just faster on the computer. [I publish things about] fractions, decimals, things like that. One time, I put that it was really cold in here, but would not write that in the web journal. On the web journal, I would write something like I was doing fractions and decimals and stuff came up with this problem, give the answer and how I got it.

APPENDIX C (cont'd)

12. [What I write in my journal and on the web is] basically the same. I write if the problem was hard or if I have to remember something to do it better later. I write it down, so I can remember it.
13. [What I write in my journal is] a little bit [different than what I write on the web] because you show what you've done, but you do the same thing in your journals, so it's not that very much different.
14. [What I write on the web is] not really [different from what I write in my journal] because when if I write something in my journal, I usually write that on the web.
15. I think [what I write in my journal is different from what I write on the web] because I always make things longer when I type so I can explain it better than when I do it in my journal because I know what I'm talking about in my journal.
16. [What I write in my journal is] not really [different from what I write on the web.] It has the same kind of main idea.

Question 3: Would you rather write in your journal or on the Web?

1. [I'd rather write] on the web [than in my journal] because it helps with your typing skills and also other people get to see it from all over.
2. [I'd rather publish] on the web [than write in my journal] because I don't really write in my journal. I don't really know what to put in there, but on the web, there's somebody else who can help you word it right or whatever when we are publishing.
3. [I'd rather publish on the web than write in my journal] because you get to review it while you are typing it.
4. It doesn't really matter [if I publish or write in my journal].
5. Yeah, I'd rather write on the web because it isn't right in front of you and the web is not like that. I can't explain why.
6. No, well, I like the web better. You don't have to have a pencil, so you can just publish.
7. [I'd rather publish] on the web [than write in my journal] because it is more fun typing than writing it down.
8. I'd rather write on the web because it is kind of fast and more fun because you get to see interesting things and see new stuff. With pen and pencil, you get used to it and gets boring.
9. Either one's fine. I like to do them both [writing on the web and in my own journal].
10. [I'd rather publish] on the web [than in my journal] because it is fun to type and to have people see your ideas.
11. [I'd rather write] on the web [than write in my journal.]
12. [I'd rather publish] on the web [than write in my journal] because I like it better. I like using computers.
13. [I'd rather publish] on the web [than write in my journal] because it helps other kids learn new things and it's fun typing.
14. [Compared to writing on my journal, I'd rather publish] on the web because it just gives you a chance to show your ideas and thoughts.

APPENDIX C (cont'd)

Question 4: You know how we have a new student in this class or choose one of your friends who is not in this class. How would you explain what the web journal is all about to him or her?

1. Every once in awhile someone gets chosen to go and write about what we're doing in class, you can choose a subject. Like, how to find the sums of adding fractions and publish what you wrote.
2. It's fun because you get to type and pick what you want to write about.
3. It's [Publishing is] like notes. At the end of the day, you just have to write down what you did.
4. You pick something, people and they publish it so other people can look at it.... To help other people on the Internet learn.
5. You have to explain what you did in class and a solution for how to do it and give them a couple of examples.
6. [Publishing is] like you explain things, explain problems, how to do special techniques, and easy ways to do things, and you just write it, just type it on.
7. I would tell him that you organize it so that we have different partner and that when you publish, you just pay attention to what's going on in class and on the computer, you can type it down on the computer and it will go through. You still have to type examples and how you got the answer or like a problem you are doing or checking over.
8. When you publish, you write what you learned from one of the lessons and show how you did it.
9. I'd say just write what you did in class on the journal, like a problem we did today. Solution strategy that he learned from Mr. Watkins.
10. I'd tell him that it's like writing in your own journal. Just think of something and type it, then ask you [Jones] if it is alright. You would put things we are doing in class.
11. On the web, you have to explain to other people what you are doing and how the problems work.
12. You write what you did in class and how to do it, the instructions to do that paper or problem and write down the ideas.
13. The web journal is a web site on the computer, you log into and have your own password and you publish things you did in class, things that you talk about in school.
14. First of all, you have to learn the stuff, then type all that you know about it... all the stuff we've been learning in class.
15. You just write about investigations you do and explain it to people like how you got your answer and what you are doing in school.

Question 5: What is the purpose?
[The purpose is] to share what you're learning with people who are reading it.
[The purpose is] so other people know how to do it or know what you are talking about.
The purpose is to explain to other people what you are doing. Like, people can click on Otto and see what we're doing.
If you are stuck on something, you can go and look back. If you forget how to do something you can look back on your notes. It could tell the teacher if you are paying attention in class or not.
The purpose is so that other people in other schools can see what you are doing.
[The purpose is] to remember things and if someone else published and you didn't understand something, you can go to their publication and read it and understand it.
[The purpose is] to help other people and let kids know what you are doing at your school.
[The purpose is] to help other kids, like maybe in the X school district or all over, to help them if they don't know or if they are doing the same thing or if they want to see how other people are doing it.
[The purpose is] so that other people can see what you learned and what you do in math class.
[The purpose is] so that other people, in smaller grades can see what we're doing if they haven't learned it yet, or older people to see what they are doing.
[The purpose is] so that other people can see what we are doing and they can learn some stuff too.
[The purpose is] so that people can see what you did in class.
[The purpose] I think is to share your ideas. People respond to it. It's not really bad if they respond to it because you know that they are reading your stuff and listening to what you have to say.
The purpose is to let other people know what we are doing in class.
The purpose is so that people can see what you are learning and so other people can learn.

Question 6: What are important things to remember while publishing? Things that you shouldn't do?

1. Shouldn't tell them the wrong way to do a problem. Remember that everybody is going to read it. Make sure you have the right answer before typing it up. You shouldn't publish the wrong answer or the wrong way to write it.
2. [In publishing, you need] to do it step by step. Like if you can say that these all go together, you have to say 2 and 2/5 plus this is what. Instead of just writing down what everything is altogether, go step by step and tell what you are doing. you should go step by step and add it together. Make sure you are spelling it right and double check the answer to make sure you know it is right.
3. You could do whatever homework you did and explain how you did it. Like your homework, you can scan it through and write what goes with it and you can cut out stuff that doesn't. You shouldn't mess around or scan stuff that shouldn't be scanned.
4. If you find something interesting, you can publish it.
5. Don't write stupid stuff or things you don't know what you are talking about. You should write about stuff you know about.
6. To stay on task, to listen to Mr. Watkins too while publishing. You shouldn't talk about other things beside our assignment, not listen to Mr. Watkins.
7. [You need to remember] how to do it. Before you publish, you have to know what you are explaining and how to do it. You know what to do when you get on there and how to explain your answers. You shouldn't play around on it.
8. Make sure other people can understand it, make sure it makes sense. You shouldn't do bad things, like English when it is about math and something that doesn't make sense.
9. Remember your problem, and how you got it, what strategies did you use. You shouldn't put the whole problem, but just part of the problem, and the examples. You could put down your answer and how you got it.
10. Don't put your name. Make sure the sentences are right and not irregular sentences and make sure what you wrote is right and like how most people do it and not wrong.
11. Everybody can see it, your audience you are writing to. Use proper spelling, punctuation, all the editing stuff and make sure your information is correct. If it isn't, everybody is going to get messed up.

12. Shouldn't type something off your brain, something you think you learned at home from your book, something you haven't talked about yet, something you don't know totally about yet.
13. To not forget it, have it there and other people can read it. Be serious about it. Pay attention in class before you publish, so you know what we are talking about that day. You shouldn't mess around with the computer and try to focus on class.
14. Just typing and trying to pay attention to Mr. Watkins at the same time, so we can still get a good participation grade and still have some fun on the computer.
15. You have to explain it really well like how you do the problem, how you get the answer, what to do. You shouldn't write something you don't explain at all and you should try it on somebody else to see if they understand it, so then other people will probably understand it too.
16. Remember to title your paper and tell what you are doing, to show it and don't just put some answers down. Make sure you show how to do it....Don't just put the answers, but make sure you tell what the questions are and what you did.
17. Write in what you talked about in class. You should reread it to make sure you put what you wanted to say. Just fill out all the information on the screen. Things you talk about in school or you can have your paper scanned. Don't use foul language and don't put your full name.
18. Just type all that you know about the subject. You shouldn't do anything else you weren't told to do, just do what you were supposed to do and not anything else. Like don't mess with things, just type your publication.
19. Make sure that people can understand what you write and choose your words carefully. Don't go to other web pages while publishing.

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Question 7: Now I am going to ask you about how you like publishing or how you find it interesting, whether you like publishing or find it interesting. So what do you think about publishing?

1.	I think publishing is neat because we get to share ideas with others outside this school.
2.	It's fun, but sometimes it takes away from class. It's hard to type and pay attention at the same time.
3.	It's fun. I think that you should have it next year to help out the kids because this has helped me a lot in understanding the computer and math because I was a bad student. I'm surprised I got into enriched math. When I explain it on the computer, I know exactly what I am saying. That helps me out with my math. When we have partners, like smart people helping us, you get it because once you read it, you say, oh, now I get it.
4.	If you don't have a pencil, you don't have to write everything down. I like looking at other people's journals, what other people have been putting on there and see if I want to put a response.
5.	I think it's a good way to learn how to do different things and learn how to, for example, if you didn't know how to do something, you can go back and learn all different kinds of things. If you didn't know how to do something and somebody published it and you were looking around on the computer and found something you didn't know how to do and you read it and they explained it really carefully, you can learn how to do it.
6.	Publishing makes sense for people to do it, not like all those things that the teacher makes you have to do. It's something people want to do... because it is fun and if you are going to help someone else and if other people are going to help you. If there is someone else in another city trying to do a problem, I can write this down and try to help them if they have a problem with it.
7.	Publishing is fun because in your journal, when you are by yourself, you might not be able to think of what to publish, but when you have a partner, you can ask them how to word it right or help you.
8.	It's interesting to see how other people learn math instead of only the way you learn.
9.	I think publishing is interesting. Sometimes, I get on the computer at my grandmother's house and get on to see what other people are doing.

10. I think it's interesting because it's a new place to explore. On the web, you can go back and say that's really cool, and that's really cool and I've never seen that before.
11. [Publishing is] fun because you get to show other people what you are doing, and so they can understand it too.
12. I think it's [publishing] fun because you get to write on the computer, put your ideas, and what you did in class. It's nice to let people know what you did in class.
13. Yeah, [publishing is interesting.] When you do it, its a group thing, compromise and think of something to put on. It's just teamwork when you put it on there.
14. I think publishing is interesting because this is the only class you get to do this kind of stuff, like typing your journals, type what you know about what you did in a certain area.
15. At first, it's kind of interesting, but it gets boring after a little bit.

Question 8: How do you like publishing compared to other activities?

1. I would rather publish than take a test or would publish and do the worksheets at home.
2. Yeah, [I'd rather publish than do other math activities] because I don't like doing the other things in math class. It's fun.
3. I like publishing. It's fun. It's more fun than other activities. When you publish on the computer, it's just more fun than sitting and doing your assignment.
4. Yeah, it's fun because it's like telling people how to do other things they don't know how to do.
5. Yeah [I'd rather publish than do other activities.] Both of them help you understand how to do it, but publishing is funner.
6. Yeah I like publishing, sometimes in class, it is boring, but when you get to publish, you can write down what you think about it, how you got the problem.
7. Yeah, I'd rather publish than other math activities] because others are boring. You get to work with the computers in publishing.
8. Yeah, [publishing is interesting] because you get to work with other students that you know. You get to type and work together and to publish something that everyone can see, that is bigger than just in the classroom, so everybody that has a computer can see it too.
9. Yeah, [publishing is interesting] because you can work others and talk about what you think is correct and what you should write on there, whatever you think everybody will understand.
10. I think it's funner than just sitting in class and just paying attention to Mr. W.
11. It doesn't matter [whether I publish or do other math activities] because I usually publish what I do in math class.
12. Yeah, [I'd rather publish than do other math activities] because you have to do other activities , but you get to sit there, learn how to use the computer, write about stuff you did in class, instead of just write down things on paper.
13. If it's just dittos, I don't mind, but like tests, I'd rather publish. It's just fun. I don't really know why, but I just like doing it.
14. I'd rather publish than any other subject in school except for gym and in math. It's fun typing in publishing. On the other hand, you don't get to do the other stuff. You don't get to learn the other stuff when you are typing.
15. I probably like the other things [math activities] better. I don't know why, I just do.
16. I think kids would rather publish than do other things in class. It's different because it let's you explain things instead of letting the teacher tell you how to do it. You can put how you think is easy to do it your own way.

Question 9: Do you think publishing is different from other activities that we do in class (makes it fun)? How? (Probe) Next year, we are thinking about having publishing but trying to understand whether we should have it. Do you think we should have it? Why should I have publishing? or what is it about publishing that you like? (Probe) How is it fun? What makes it fun?

1.	[Publishing is different from other activities] because you are using a computer and sharing it with everybody else, whoever looks at the Internet, share what you did in class.
2.	[Publishing is different from other activities,] like with worksheets, you have to do that alone, but with publishing you get to go up and work with a partner.
3.	[Publishing is different from other math activities] because you get to use the computer, you get to put what you say, so everyone in the entire world can read it. You can put it in your own words, but you have to make sure other people can understand it.
4.	Yeah, it's funner because of typing and looking through the stuff like what you wrote. Like when you go through the stuff and see what goes with the stuff. It's fun going through and seeing what other people wrote. And you have a password so you can put in your own thing.
5.	Publishing is different because with a worksheet, you just put down the answer, but with the publishing you have to explain your answer, how you got it. It's better to explain your answer than just right down the answer because if you get the answer from somebody, you can't explain it. But if you publish, you have to explain it.
6.	It's different [from other math activities] because, in our classroom, the only people who get to see what you are doing is in your class, but when you publish, other kids get to see it too.
7.	Publishing is different because you use computers and in other activities we don't use the computer as much.
8.	Publishing is different because you use computers, you write solution strategies, not just talk about them, so you can remember them. It's not just problems, but solution strategies, ways to solve stuff and you can make up your own problems, too.
9.	Yeah publishing is different. If you are just sitting there listening to Mr. Watkins, it gets boring, but publishing is fun.
10.	Yeah, [other math activities are different] like with the overhead, we draw graphs and shades things in, and we don't do that in publishing.

11. [Other math activities are] sort of [the same as publishing] because you write down what you did down in class, so it is sort of the same, but you don't just do it, you write about what you did.
12. [Publishing is] not really [different from what you do in other math activities.] You just talk about what you are doing. When you publish, you talk about the ditto sheet or what you did in class today.
13. I think publishing is different from other activities. Usually in other activities, you don't get to type, you just write problems. Here you can explain why you put something down, why or how you came up with the answer.
14. Publishing helps other people and gives you a chance to do other things you don't know how to do. If you publish and let everybody see it, you feel happy because you taught somebody how to do something that they didn't know how to do. If you didn't have publishing, most people couldn't learn as much stuff because they couldn't look through and see if anybody has put anything they did not know.
15. When you publish, you are not by yourself, and sometimes kids don't do the work because they have to sit by themselves or do it by themselves and don't understand it. But when you are publishing and you put down a problem, you have a friend there who can help you solve the problem or a friend who can help you think of a problem to put down. It is also fun because it lets you show other kids, not just those you are working with, it shows other kids.
16. Yeah, because other people can learn how you learn and it's fun.
17. Yeah [I think you should have publishing next year.] I think it is interesting because it gives kids a break from Mr. W. talking and it is a new thing to learn.
18. With other stuff, all you got to do is work. This is fun, though. ...On the web, you don't have to do tests or other assignments. You just got to write down one example problem and tell what it is about.
19. When you are publishing on the computer, you give other people chances to learn, other people on the Internet.
20. I don't know [why publishing is fun]. I think it is that you just basically get to work with your friends.
21. You miss out on the other stuff sometimes. It's just fun doing things on the computer.

Question 10: Do you think that publishing on the Web leads you to do math or makes you want to do math more? Why?

1. It makes learning math more interesting because you get to type on the computer and write about what you are doing in class.
2. Once you do your math more, you get to publish more. If you don't do your math, you can't publish because you don't have anything.
3. If you are publishing and others are doing the classwork, the publishers usually have to do it at home and turn it in. I don't mind because you have all night to do. I'd rather publish and do that at home. Except when I don't know what we are doing covering in class.
4. When you are publishing, you are talking about math problems, and it just makes you want to do math more.
5. No, [publishing does not make me want to do math more], not that much.
6. Yeah, [publishing does make me want to do math more] because when I publish I start writing something and think, oh my gosh, it does really work and start using it.
7. Yeah, [it makes me want to math more] because if other kids like it from wherever, then your teacher might like it too. If you are with your partner and doing a problem and they like it too, the teacher might like it too.
8. Not really, [publishing doesn't make me want to do math more.]
9. Yeah, [it makes me want to do math more] because you want to learn stuff. When others login, they can see your initials and decide to read yours. They can learn from them. I think it's cool. I get to see other solution strategies and I get more involved in math because I learn more stuff everyday. And I get to write more stuff. After I type stuff, I want to learn more about that subject and publish more on that subject.
10. No, I think it is a more interesting way of taking a break. Instead of saying that you are going to put down your pencil and take a break, you can just go to the computer and take a break while you are working.
11. Yeah, [publishing makes me want to do math more] because it's easier to explain and you'll be able to explain more stuff.

12. Yeah, [publishing makes me want to do math more] because it is fun. You get to learn more about what you are doing that way. That makes you understand it more. Once you think about it more to write it down, it makes you understand the problem more.
13. Yeah, [publishing makes me want to do math more] because if you don't do the homework, you won't be able to do that because you don't know what you are doing, so it helps the kids because it is fun to do that, so they get to do that, so they should do the homework. It makes them think I better do this if I want to write on the computer tomorrow.
14. Yeah, sometimes, if I am in science, I think about things I would put on the web. Usually the class after because I think about that I could have put that on before instead of this or something... or what I may want to do.
15. Yeah, [publishing makes you want to do math more because] it makes you want to get to math class or for first class because you are eager to do it.
16. No [publishing does not make me want to do math more.]

APPENDIX D

AUDIENCE

1. [Publishing is sort of different from writing in the individual journals] because when you publish in your journal it's just for you, but when you publish on the Internet, it's for everybody else.
2. Yeah [publishing the journal on the web is different from writing in the individual journals], because everybody else can see it and they don't have to ask you. They can just get on and see it.
3. Yeah, [the web journal is different from writing in your own journal] because other people can read them not just teachers, and they can login from home to read it.
4. Yeah, [what I write in my journal is different than what I write on the web.] You go into more detail on the web. People explain it better so other people can understand it.
5. Because you are using the computer, sharing your ideas.
6. [Publishing], it's fun because it gives you a chance to explain to other kids, how to do a problem or how you got the answer or examples of what you did.
7. I like publishing on the web [versus just writing on the computer] better because other people can see what you wrote. If you just typed it on something, not everybody would see it.
8. Publishing is interesting because kids that don't know how to do things get a chance to learn about computers, not only computers, but the Internet. People respond to their journals and may get better ideas of what they have been doing. For example, I put a math problem, an example on the Internet and Shanon corrected it because I made a couple of mistakes.
9. [I'd rather write] on the web [than in my journal] because it helps with your typing skills and also other people get to see it from all over.
10. On the web, you have to explain to other people what you are doing and how the problems work.
11. The purpose is to explain to other people what you are doing. Like, people can click on Otto and see what we're doing.
12. The purpose is so that other people in other schools can see what you are doing.
13. [The purpose is] so that other people can see what you learned and what you do in math class.

14. [The purpose is] so that people can see what you did in class.
15. [The purpose] I think is to share your ideas. People respond to it. It's not really bad if they respond to it because you know that they are reading your stuff and listening to what you have to say.
16. The purpose is to let other people know what we are doing in class.
17. Make sure other people can understand it, make sure it makes sense. You shouldn't do bad things, like English when it is about math and something that doesn't make sense.
18. Everybody can see it, your audience you are writing to. Use proper spelling, punctuation, all the editing stuff and make sure your information is correct. If it isn't, everybody is going to get messed up.
19. Make sure that people can understand what you write and choose your words carefully. Don't go to other web pages while publishing.
20. I think publishing is neat because we get to share ideas with others outside this school.
21. [Publishing is] fun because you get to show other people what you are doing, and so they can understand it too.
22. I think it's [publishing] fun because you get to write on the computer, put your ideas, and what you did in class. It's nice to let people know what you did in class.
23. Yeah, [publishing is interesting] because you get to work with other students that you know. You get to type and work together and to publish something that everyone can see, that is bigger than just in the classroom, so everybody that has a computer can see it too.
24. Yeah, [publishing is interesting] because you can work others and talk about what you think is correct and what you should write on there, whatever you think everybody will understand.
25. [Publishing is different from other activities] because you are using a computer and sharing it with everybody else, whoever looks at the Internet, share what you did in class.
26. It's different [from other math activities] because, in our classroom, the only people who get to see what you are doing is in your class, but when you publish, other kids get to see it too.
27. Yeah, [it makes me want to math more] because if other kids like it from wherever, then your teacher might like it too. If you are with your partner and doing a problem and they like it too, the teacher might like it too.

APPENDIX E

TEACHING AND LEARNING

We can teach others

1. Yeah, [the web journal and my journal are different] because in the math journal, the only people who see it are you (Jones) and Mr. Watkins, but on the web, other kids who are having problems or whatever, they can look on our sheet.
2. No, [it isn't the same if students just wrote their journal on the computer and not the web] because on the web, other people can see what you do and it can help them more. [This is an important] because other people need to learn too.
3. [I'd rather publish] on the web [than write in my journal] because it helps other kids learn new things and it's fun typing.
4. You pick something, people and they publish it so other people can look at it.... To help other people on the Internet learn.
5. [The purpose is] to share what you're learning with people who are reading it.
6. [The purpose is] so other people know how to do it or know what you are talking about.
7. [The purpose is] to help other people and let kids know what you are doing at your school.
8. [The purpose is] to help other kids, like maybe in the X school district or all over, to help them if they don't know or if they are doing the same thing or if they want to see how other people are doing it.
9. [The purpose is] so that other people, in smaller grades can see what we're doing if they haven't learned it yet, or older people to see what they are doing.
10. [The purpose is] so that other people can see what we are doing and they can learn some stuff too.
11. The purpose is so that people can see what you are learning and so other people can learn.
12. Yeah, it's fun because it's like telling people how to do other things they don't know how to do.
13. Yeah, because other people can learn how you learn and it's fun.
14. [I'd rather publish than write in my journal because] of typing, telling how to do it, and publishing.

We can learn

1.	[The purpose is] to remember things and if someone else published and you didn't understand something, you can go to their publication and read it and understand it.
2.	It's fun. I think that you should have it next year to help out the kids because this has helped me a lot in understanding the computer and math because I was a bad student. I'm surprised I got into enriched math. When I explain it on the computer, I know exactly what I am saying. That helps me out with my math. When we have partners, like smart people helping us, you get it because once you read it, you say, oh, now I get it.
3.	Publishing makes sense for people to do it, not like all those things that the teacher makes you have to do. It's something people want to do... because it is fun and if you are going to help someone else and if other people are going to help you. If there is someone else in another city trying to do a problem, I can write this down and try to help them if they have a problem with it.
4.	Publishing helps other people and gives you a chance to do other things you don't know how to do. If you publish and let everybody see it, you feel happy because you taught somebody how to do something that they didn't know how to do. If you didn't have publishing, most people couldn't learn as much stuff because they couldn't look through and see if anybody has put anything they did not know.
5.	Yeah, [publishing does make me want to do math more] because when I publish I start writing something and think, oh my gosh, it does really work and start using it.
6.	Yeah, [it makes me want to do math more] because you want to learn stuff. When others login, they can see your initials and decide to read yours. They can learn from them. I thinks it's cool. I get to see other solution strategies and I get more involved in math because I learn more stuff everyday. And I get to write more stuff. After I type stuff, I want to learn more about that subject and publish more on that subject.
7.	Yeah, [publishing makes me want to do math more] because it is fun. You get to learn more about what you are doing that way. That makes you understand it more. Once you think about it more to write it down, it makes you understand the problem more.
8.	It's interesting to see how other people learn math instead of only the way you learn.

APPENDIX F

OWNERSHIP

1. [If the teacher picked what you had to write about instead of letting you pick want you wanted to write,] I don't think it would be done as well. If you publish about what you want to publish, then you know what you are going to say, and if you have to publish what you want us to publish, you have to figure out what you are going to say and how to figure it out instead of what we already had planned for it or what was already in our journal.
2. Yeah, it would be different [if you told us to type on a specific topic instead of letting us choose our own] because the stuff that you want to type, you'll know and the stuff you want us to type, we might not know about.
3. Yeah, because if you don't know what you are doing, you'll just be sitting there writing about something you don't know. If you don't know what you are going to do right then, you can think of something.
4. [Compared to writing on my journal, I'd rather publish] on the web because it just gives you a chance to show your ideas and thoughts.
5. It's fun because you get to type and pick what you want to write about.
6. First of all, you have to learn the stuff, then type all that you know about it... all the stuff we've been learning in class.
7. Don't write stupid stuff or things you don't know what you are talking about. You should write about stuff you know about.
8. [You need to remember] how to do it. Before you publish, you have to know what you are explaining and how to do it. You know what to do when you get on there and how to explain your answers. You shouldn't play around on it.
9. Just type all that you know about the subject. You shouldn't do anything else you weren't told to do, just do what you were supposed to do and not anything else. Like don't mess with things, just type your publication.
10. I think publishing is interesting because this is the only class you get to do this kind of stuff, like typing your journals, type what you know about what you did in a certain area.
11. Yeah I like publishing, sometimes in class, it is boring, but when you get to publish, you can write down what you think about it, how you got the problem.
12. I think kids would rather publish than do other things in class. It's different because it let's you explain things instead of letting the teacher tell you how to do it. You can put how you think is easy to do it your own way.
13. To not forget it, have it there and other people can read it. Be serious about it. Pay attention in class before you publish, so you know what we are talking about that day. You shouldn't mess around with the computer and try to focus on class.

APPENDIX G

COLLABORATION

1.	Publishing is like doing math, but doing it on the computer and writing it out instead of just reading it and doing it. You are writing it out. I think it would be more boring if you just did your own journals because, on the web, you get to work with a partner. When you look at other people's work, you can cut out the stuff that doesn't go with it. If they put, 'oh, I forgot to mention I got an A.' You can cut that out because that has nothing to do with it.
2.	No, it's not that different [from publishing if you get to work with other people in another activity.] It don't make any difference because you still have kids helping you.
3.	It [publishing] is different from how we did math because we used to just have the blackboard and no journals. It makes it a little more interesting and different because you get to work with someone else and both of the people are trying to figure it out. I like that better.
4.	[I'd rather publish] on the web [than write in my journal] because I don't really write in my journal. I don't really know what to put in there, but on the web, there's somebody else who can help you word it right or whatever when we are publishing.
5.	Publishing is fun because in your journal, when you are by yourself, you might not be able to think of what to publish, but when you have a partner, you can ask them how to word it right or help you.
6.	Yeah, [publishing is interesting.] When you do it, its a group thing, compromise and think of something to put on. It's just teamwork when you put it on there.
7.	When you publish, you are not by yourself, and sometimes kids don't do the work because they have to sit by themselves or do it by themselves and don't understand it. But when you are publishing and you put down a problem, you have a friend there who can help you solve the problem or a friend who can help you think of a problem to put down. It is also fun because it lets you show other kids, not just those you are working with, it shows other kids.
8.	I don't know [why publishing is fun]. I think it is that you just basically get to work with your friends.

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