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ABSTRACT

This paper describes the struggles of one professional development project as it attempted to use networking technology to promote ongoing reflection and community building among its participating teachers. It employs Riel and Levin's (1990) framework for participant structures in computer networking environments to consider the strengths and weaknesses of the online portion of the project in terms of encouraging participation. The paper reports data from two consecutive cohorts of teachers showing how difficult it can be to establish online community participation as a component of teachers' work-life. The 17 participants in the first year of the Teaching Mathematics with Technology Project (TMTP) (2000-2001) were practicing secondary mathematics teachers (grades 6-12) from 9 different schools. Participants varied widely in terms of number of years of teaching experience (ranging from 1 to 25 years), mathematics courses taught (ranging from pre-algebra to pre-calculus to AP statistics), and experience teaching with educational technologies (ranging from almost no use to everyday use). All 11 participants in Cohort 2 (2001-2002) are practicing secondary mathematics teachers (grades 8-12) from 4 different schools. These teachers are very similar to those in the first cohort in terms of years of teaching experience (2-20 years), courses taught, and experience with educational technologies. Although the TMTP is an ongoing professional development program, this study reports data from the first two years of this project, referring to the two groups of participating teachers as Cohort 1 and Cohort 2. The goals of the TMTP are twofold. First, the project aims to familiarize secondary mathematics teachers with various educational technologies and to encourage them to consider how such technologies might be used to enhance their students' understandings of mathematics. A second goal of the project is to build a community of mathematics teachers who share an interest in teaching with technology and who can support their own professional development apart from their involvement in the TMTP. A threefold professional development strategy is employed: a summer institute, monthly follow-up meetings, and an online forum for professional networking. Two appendixes include follow-up activity sheets. (Contains 10 references.) (AEF)

Using an Online Discussion Forum to Engage Secondary Mathematics Teachers in Teaching with Technology

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Educational technologies are essential tools for learning and doing mathematics (National Council of Teachers of Mathematics, 2000). Although technology allows students to work more independently, the teacher's role in a technology-rich classroom is more demanding than ever. Teachers who choose to incorporate technology into their mathematics classrooms must understand when and how technology can be used to enhance their students' learning opportunities. They must select or create appropriate technology-based tasks. And, they must remain cognizant of their students' thinking as they work on these tasks in order to make appropriate instructional decisions. These increased demands signal a clear need for professional development focused on helping teachers achieve levels of technological literacy that support the current goals of mathematics education.

Less obvious is how to provide this necessary professional development in a way that encourages teachers—who spend most of their time in classrooms isolated from one another and from other opportunities for professional growth—to view themselves as life-long learners. Guskey (1995) argues that the teachers themselves must come to view professional development as a process rather than as an event. In order for this to occur, the isolated "inservice days" model of professional development will need to be replaced with a model that continually supports teachers' need for growth. Stein, Silver, and Smith (1998) propose that teacher development occurs best through the building of communities of collaborative, reflective practitioners. Riel (1996) supports such community building, arguing that through collaborative intellectual exchange teachers can support one another's professional development. If we are to meet this vision, professional developers must tackle the difficult task of promoting such professional networking and community building within the limited time that teachers' have available in the existing school workplace.

Our goal in this paper is to describe the struggles of one professional development project as it attempted to use networking technology to promote ongoing reflection and community building among its participating teachers. We employ Riel and Levin's (1990) framework for participant structures in computer networking environments to consider the strengths and weaknesses of the online portion of the project in terms of encouraging participation. We report data from two consecutive cohorts of teachers showing how difficult it can be to establish online community participation as a component of teachers' work-life.

*The Teaching Mathematics with Technology Project (*TMTP*)*

The Participants in the Project. The 17 participants in the first year of the TMTP (2000-2001) were practicing secondary mathematics teachers (grades 6-12) from 9 different schools. Four of these teachers were from the same school. These participants varied widely in terms of number of years of teaching experience (ranging from 1 to 25 years), mathematics courses taught (ranging from pre-algebra to pre-calculus to AP statistics), and experience teaching with educational technologies (ranging from almost no use to everyday use). One faculty member and two graduate students led the project.

All 11 participants in Cohort 2 (2001-2002) are practicing secondary mathematics teachers (grades 8-12) from 4 different schools. Six of these teachers are from the same school. These teachers are very similar to those in the first cohort in terms of years of teaching experience (2-20 years), courses taught, and experience with educational technologies. The project is led by the same faculty member who led the project during year one and one graduate student who did not work on the project during year one but did attend several of the academic-year sessions during year one to gain familiarity with the project.

Although the TMTP is an ongoing professional development program, in this study we report data from the first two years of this project, referring to the two groups of participating teachers as Cohort 1 and Cohort 2. The goals of the TMTP are twofold. First, the project aims to familiarize secondary mathematics teachers with various educational technologies (e.g., graphing calculators, geometry software, data collection peripheral devices) and to encourage them to consider how such technologies might be used to enhance their students' understandings of mathematics. A second and equally important goal of the project is to build a community of mathematics teachers who share an interest in teaching with technology and who can support their own professional development apart from their involvement in the TMTP. The pursuit of these goals employs a threefold professional development strategy: a summer institute, monthly follow-up meetings, and an online forum for professional networking.

The Summer Technology Institute. The TMTP teachers spend a two-week summer session using various technologies to explore mathematics activities and discuss appropriate ways to use technology with their high school students. The goal is not solely to teach teachers how to use, for example, a graphing calculator, or to provide teachers with a collection of activities to give their students. The goal, rather, is to encourage teachers to reflect on and discuss the affordances of technology in helping students learn mathematics. In the context of collective mathematical exploration, teachers consider how appropriate use of technology might expand the scope of what their students learn and do in the classroom.

Follow-Up Professional Development Meetings. The second component of the TMTP consists of six after-school inservice workshops following up on the summer institute. Each of these sessions involves a detailed examination of one particular technology and content area (e.g., working with functions using Geometer's Sketchpad). Using a content immersion

approach, teachers are asked to put themselves in the role of learner, exploring mathematical problems with technology on their own, before discussing both how their students might respond and the mathematical concepts behind each of the activities.

Online Professional Development Forum. Because a goal of the TMTP is to encourage the building of a community of teachers, the project supports a web page with resources to support teacher inquiry and collaboration. The web page introduces teachers and other visitors to the project and its goals, provides contact information, lists the participating teachers and schools, and includes lesson plans developed by TMTP teachers and links to other technology web sites. At the onset of the project the developers believed that offering such resources on a project-sponsored website would provide incentive for teachers to explore the site and find their way to the password-protected asynchronous discussion forum.

The online discussion forum is supported using First Class, a software application package that allows users to send and receive mail and engage in asynchronous electronic conferencing with other users. Organizing discussions into threads is possible, although an administrator rather than the participants must create this level of structure. First Class also allows for real-time chat with other users, although this feature of the software was not utilized by the TMTP. The TMTP staff believed that providing the opportunity for teachers to engage in asynchronous discussions through First Class would strengthen professional culture and further support the participants' professional development.

Theoretical Framework

Riel and Levin (1990) propose that five "network participant structures" guide the analysis of group interaction on computer networks, including those for teacher professional development: (a) *organization of the network group* includes size, common knowledge and

interests, past experiences, and the physical location of the participants; (b) *network task organization* concerns the types of activities in which the participants engage online; (c) *response opportunities* involve issues of access to technical resources; (d) *response obligations* include the tacit or formal requirements for responses in terms of time and quality; and (e) *evaluation and coordination* involves any assessment of the quantity or quality of the online exchanges.

Levin, Kim, and Riel (1990) further elaborate some specific criteria for network success: (a) a group of people who work together or share interest in a task, but who find it difficult to meet in the same location and/or at the same time; (b) a well-specified task to be accomplished by this group; (c) ease of access to a reliable computer network; (d) a sense of responsibility to the group and/or task; and (e) strong leadership and final evaluation of the group task. Riel and Levin (1990) discuss the participation structures of several online communities of university researchers, elementary students, and teachers undergoing professional development and conclude that while it is often difficult to ensure that all of the above criteria are met, successful networks deviate from this pattern by only a single feature while unsuccessful networks deviate by two or more features. Table 1 illustrates the theoretical and practical implications of this framework as they applied to the unfolding of the TMTP.

Table 1. Framework for Evaluating a Networking Community (Riel & Levin, 1990).

Network Qualities	Determinants of Success
Organization of Network	Existence of shared interests among a group that is physically or temporally unable to interface for dialogue or sharing resources
Network Task	Agreement upon the nature of productive and reactive communications on the network
Response Opportunities	Ease of access to reliable computer network
Response Obligations	Acceptance of a shared commitment to make productive and reactive contributions to the network
Evaluation and Coordination	Centralized or decentralized locus of control regulating patterns of contribution and response

In what follows, we use this framework to analyze the successes and failures of the TMTP's online professional development component. We pay particular attention to how participant structures may have undergone change from the first year of the TMTP to the second as TMTP professional developers attempted to increase participation in the online discussion forum.

Results of Year One

In year one, the project website and discussion forum were introduced to the Cohort 1 teachers during the first follow-up session of the academic year. Teachers received instruction about the First Class login procedure and project staff discussed the goals of the online forum. The project director posted an introductory message to the discussion board welcoming teachers to the site:

> *Welcome to the TMTP discussion forum. The purpose of this forum is to allow us to discuss issues regarding teaching with technology throughout the year rather than solely at our follow-up meetings. The idea is to pose questions, teaching dilemmas, ideas, or respond to others' comments. I hope you log-on to the discussion forum periodically so that we can continue our conversations about using technology in teaching mathematics.*

Another message provided teachers an introductory online "assignment" to be completed sometime before the next face-to-face meeting:

> *Share a "technology success" story from your teaching. In other words, describe a successful lesson in which you implemented technology; include in your description why you thought the lesson was successful.*

It was believed that this task offered teachers a positive, non-threatening first experience with the online forum that would encourage further discussion of other issues surrounding the teaching of mathematics with technology.

Although the Cohort 1 teachers eagerly engaged in mathematics with their colleagues during the summer workshop and first follow-up session their response to this prompt was tepid, at best. Throughout the first year, this pattern of active in-class participation and nonparticipation in the online forum continued. For example, the second follow-up session of the academic year took place approximately 5 weeks after the first. As of this date, only two teachers had posted a technology "success story" to the online discussion board. A reminder at this second face-to-face meeting prompted three more to do so within the week.

Although the instructors used every meeting to encourage teachers to stay connected with each other via the project discussion board, with the exception of the "success story" request, no further discussion prompts were offered during year one. It was assumed that teachers would eventually participate by raising issues and concerns to discuss with colleagues. This did not happen. The five "success story" contributions were the only posts to the discussion board during the course of the entire school year.

Discussion of Year One

Why did TMTP teachers choose not to participate in the online discussion forum? Results of survey data indicate that all participating teachers had access to computers at home and at school, all had email accounts they used at least weekly (most reported daily use), and all had access to the Internet. While in many professional development projects access to technology is a serious concern, the TMTP was fortunate that all participating teachers had the necessary access and experience.

Did the teachers fail to see peer dialogue as a component of their professional development? The quality dialogue in the face-to-face meetings indicates this was clearly not the case. Judging from teachers' comments on the final project evaluation, neither was a lack of interest in networking. In fact, the majority of teachers either mentioned how much they enjoyed networking and building professional relationships with other teachers or that they would like to have more opportunities to network in the future. The fact that the teachers had the desire to network with colleagues and had the necessary technology to engage in online discussions but chose not to do so suggests that the problem lay elsewhere.

At the conclusion of year one, the Cohort 1 teachers were asked about the usefulness of the online forum. Several teachers indicated that one reason for their lack of participation is that they did not know what to write *about*. Several teachers stated that they wished they had "something to focus on." In the final project evaluation, one teacher wrote, "I would like to see the website incorporated more, but motivating questions would be necessary." Comments such as these indicate that simply establishing an online discussion forum, familiarizing teachers with the procedures required for posting and reading messages, and making sure that all teachers have

the necessary access to technology will not ensure that meaningful discussion will take place or that an online community of learners will emerge.

Using Levin et al.'s (1990) criteria for successful networks as a lens with which to examine the experiences of Cohort 1 teachers, it is not surprising the network failed. Of their five criteria, only the third—*ease of access to a reliable computer network*—was clearly met.

The first requirement—*a group of people with common interests who find it difficult to meet in the same location and/or at the same time*—was only partially met. While the participants were all interested in learning and teaching mathematics with technology, a variety of areas of teaching expertise, curricula, and experience were represented. It is possible that the day-to-day experiences of these teachers were not compatible enough to foster meaningful collaboration. In addition, 4 of the teachers (roughly 25%) came from the same high school. It is possible that the face-to-face contact these teachers experienced on a daily basis lessened their perceived need to collaborate online with each other or with others in the project.

Levin et al.'s (1990) second requirement—*a well-specified task*—was definitely not met. With the exception of the initial request to share a technology success story, Cohort 1 teachers were basically instructed to write about "anything, anytime." More structure was clearly needed.

Levin et al.'s (1990) fourth requirement—*a sense of responsibility to the group and/or task*—and fifth requirement—*strong leadership and final evaluation of the group task*—also failed to be met among Cohort 1 teachers. Discussion was encouraged but not required or evaluated by the instructors. Furthermore, none of the participants themselves fostered a sense of responsibility or obligation among colleagues.

From the perspective of the TMTP staff, it was inappropriately assumed that because Cohort 1 teachers had the necessary access to and experience with networking technology, online

discussions would naturally unfold. Riel and Levin (1990) liken the setting up of an online discussion board to the setting up of a physical space and argue that clear educational objectives and goals are needed:

> No one would suggest that inviting teachers to spend the afternoon in the same building will result in their professional development. To expect that teachers will simply share their knowledge with one another in an open discussion format on a network ignores the need for organizational structure that is taken for granted in other forms of social interaction. (p. 157)

During year one this lesson became evident to the TMTP.

Results of Year Two

In response to such overwhelming nonparticipation during the first year of the TMTP, two purposive actions were taken with Cohort 2 (n = 11) to encourage online participation. First, teachers were introduced to the project web page and online forum on the first day of the summer institute. The teachers explored the features of the project web site, browsed through the activities developed by Cohort 1, and chose one to describe for the rest of the group. They were then introduced to First Class and asked to post a message sharing this activity and describing how they might use the activity with their own students. The teachers were able to immediately read the contributions of their colleagues. By having teachers experience the online forum for the first time as a group, rather than at home, this activity modeled an online, asynchronous discussion. The instructors assisted with any technical difficulties that arose.

At the end of this first day, the instructors asked the teachers to make another discussion board contribution from home, either reflecting on their goals for the two-week summer session or sharing their experiences teaching mathematics with technology. Almost all participants responded in a thoughtful manner, reflecting on how they would like to incorporate graphing calculators or The Geometer's Sketchpad into their existing courses or briefly describing a

specific lesson in which they used technology. A week later, teachers were given another "homework prompt" which asked them to reflect on a particular aspect of the activities they had experienced over the course of the summer session:

> *We have looked at several activities that involved collecting data. In several cases we ended up with messy data and the problem of uncertainty about the final answer.*
>
> *Is this a good thing in a mathematics classroom?*
>
> *Do you have any strategies for dealing with this uncertainty?*

All teachers again responded to this prompt in a thoughtful manner, often writing several paragraphs about the advantages and disadvantages of teaching lessons using "messy data." A TMTP instructor posted his own responses to several of the teachers' comments for all to read in an attempt to generate a thread of discussion. Despite these efforts, all of the postings made by teachers during the summer session consisted of individual comments in response to specific requests by the instructors rather than in response to colleagues' comments. In fact, in a few cases the teachers' responses were addressed to the instructor by name rather than to the group.

As the TMTP transitioned to the follow-up session phase, the project encouraged online participation by providing motivating prompts as requested by the Cohort 1 teachers. While encouraging discussion of any issue related to the teaching of mathematics with technology, teachers were also provided with specific tasks. At the end of each follow-up session, teachers were given a mathematical exploration that could be conducted with or without technology. For example, the second follow-up session focused on working with matrices on the TI-92 graphing calculator. During the session the teachers explored families of linear functions and the relationships among coefficients in the equations of these functions (Appendix 1). Towards the end of the session, the teachers began an activity to investigate families of quadratic functions (Appendix 2). The instructor encouraged the teachers to try these activities with their students

and then share their experiences online. Unfortunately, despite such focused tasks and the use of email reminders to encourage discussion board contributions, only one contribution—approximately one week into the school year—was made after the last posting of the summer session.

In a mid-year survey completed by Cohort 2 teachers, all listed numerous ways in which they collaborate with colleagues, including taking university classes together, planning lessons together, and chatting informally about teaching. When asked, "Do you think email/Internet use is a good way to communicate with colleagues about teaching?" five responded positively, though one of these indicated a preference for face-to-face communication. Reasons included to have a written record of notes and because "I can do it when it fits my schedule." The remaining six demonstrated reservations about the ability one has to communicate effectively online, with several indicating that online communication can be "awkward" and "difficult to keep going." One teacher wrote that it is hard to "communicate details and subtleties of a lesson or activity" online.

The reasons teachers attributed to the minimal participation in the online discussion forum included the nature of online communication as well as another important barrier: time. Seven of the eleven teachers completing the survey pointed to time constraints as a major reason for the lack of online activity. A teacher whose views were representative of the group wrote, "Time! With all the other things that go on: family, teaching, communicating with parents and students, it's hard to take more time away from yourself and family to do that."

Discussion of Year Two

The second cohort of teachers proved similar to the first in terms of high-level engagement during face-to-face meetings. Attendance during the summer and academic-year

sessions was and continues to be excellent, with teachers clearly motivated by the planned activities. Cohort 2 teachers are also similar to Cohort 1 in terms of present technology use. All of the teachers have computers at home and at school, all have Internet access at school, all but one have Internet access at home, and all use email on a regular basis in one or both places to communicate. Access to technology was therefore, again, not the barrier to online participation. Neither—judging from the survey results mentioned above—was a general lack of interest in collaboration.

If we again use Levin et al.'s (1990) five criteria as a lens with which to evaluate the online component of the TMTP, it is clear that significant improvement had been made in the transition from Cohort 1 to Cohort 2 but that the complexities associated with conducting a professional development project made meeting all five criteria difficult.

The only one of Levin et al.'s (1990) criteria clearly met with Cohort 1—*ease of access to a reliable computer network*—was again easily met with Cohort 2. All Cohort 2 teachers had easy access to the Internet and prior experience navigating the Internet. Technology was, again, not a barrier the TMTP instructors needed to consider.

Improvements were made meeting several of Levin et al.'s (1990) other criteria, most notably the existence of *a well-specified task.* Recognizing the inadequacy of instructing teachers to write about "anything, anytime," the TMTP instructors asked teachers to respond to very specific prompts during the summer institute and between follow-up sessions. One instructor in particular took the lead in providing motivating questions for teachers to consider and responding online to teachers' contributions in an attempt to further discussion, meeting Levin et al.'s requirement for *strong leadership and evaluation of the group task.*

The remaining two of Levin et al.'s (1990) criteria for successful computer networks remained difficult to meet during the second year of the TMTP. As in year one, *the existence of a group of people with common interests who find it difficult to meet in the same location and/or at the same time* was questionable. A variety of teaching interests (e.g., middle school mathematics, algebra, pre-calculus) were again represented, and a concentration of teachers from the same school was even stronger than in the case of Cohort 1, with six of the eleven Cohort 2 teachers coming from the same school.

In addition, Levin et al.'s (1990) fourth requirement—*a sense of responsibility to the group and/or task*—again failed to be met. Despite purposive action by the TMTP instructors to provide motivating questions, the online forum fell silent with the beginning of the school year. A sense of obligation was not fostered by TMTP instructors or by the teachers in the group.

Discussion of Online Professional Networking

As illustrated, the effort to sustain an electronic network for the TMTP teachers was unsuccessful as the network either failed to thrive from the beginning (in year one) or quickly fell silent (in year two). Riel & Levin's (1990) network participant structures framework provides formalism for discussing the struggles of the TMTP.

Organization of the network group. Despite the common interest in teaching with technology that the participants in each cohort brought to the project, the wide variety of course interests and the large concentration of same-school colleagues within each cohort made it difficult to meet Levin et al.'s (1990) organization of network requirement. However, this failure points to important tension in teacher professional development. As several of the teachers pointed out in their survey responses, it is difficult to describe the complexities of the classroom by email. Perhaps what we can learn from this failure is that face-to-face meetings

offer benefits to teachers that cannot be simulated in textual communication. Therefore, if establishing teacher community is a goal of professional development, then perhaps an alternative strategy, such as recruiting teams of participants from schools, is a better alternative.

Network task organization. Levin et al. (1990) assert that well-specified tasks are an integral part of successful networks. With the exception of the initial request to share a technology success story, Cohort 1 teachers were given no specific discussion prompts. It was assumed that the teachers' desire to continue their professional contacts during the course of the school year would translate into regular use and that specific tasks on which to focus would not be necessary. This lack of focus is an important factor in the TMTP online discussion forum's failure during its first year. As Moller (1998) notes, "the use of technology does not spontaneously cause communities to occur" (p. 120).

Cohort 2 teachers were introduced to the online forum on the first day of the summer institute and were asked to respond to several very specific tasks during the course of this summer institute. These tasks were completed first in the computer lab with guidance, and later in the teachers' homes independently. Mathematical activities were provided to teachers at each follow-up session with encouragement to try the activities with their students and then share their experiences online. The use of focused prompts distinguishes the organization of year one from year two. Such prompts resulted in high levels of participation during the summer institute but were not enough to sustain participation into the school year.

Response opportunities. In both years, all participating teachers had easy access to the Internet at school and in all but one case at home, fulfilling an important requirement of successful networks. In addition, all had at least some prior experience navigating the Internet.

The results of this study indicate that while such an infrastructure is a necessity, it is not enough to guarantee participation.

Response obligations. While there was an increase in organization and focus during the second year of the project, teachers in both groups were still under no strict obligation to use the network in a specific way. The minority of teachers who opted to enroll in the project for college credit were not evaluated on the basis of their online participation. The activities Cohort 2 teachers received to try with their students and discuss online were not explicit assignments. The instructors encouraged teachers to participate, but there were no external rewards (e.g., good grades) for doing so. It was hoped that the teachers would feel that participation would help them grow professionally and that they would make the decision to engage online for this reason. This implementation fell short of establishing amongst the participants a sense of responsibility to the group or task. The instructors did not insist on participation and, as no one contributed to the online discussion board during the academic year, response obligations did not arise from within the group either. Participants simply did not come to see online communication about teaching as part of the daily life of a teacher.

Evaluation and coordination. Levin et al.'s (1990) fifth requirement is that networks provide strong leadership and final evaluation of the group task. Riel and Levin (1990) assert, "someone needs to take the responsibility of facilitating the discussion" (p. 158). During Cohort 2's summer session, the graduate student working on the project took on this responsibility, introducing teachers to the network, proposing topics upon which to engage in discussion, and publicly responding to teachers' contributions. In fact, one-fifth of the contributions made during the summer session came from the instructors. It was made clear to teachers early in the

project that their comments were being thoughtfully read. During the school year the evaluation issue was rather moot, as a there was no discussion to facilitate or evaluate.

Conclusion

At the onset TMTP staff believed that online discussion forums could provide networking opportunities for teachers while making the most of their busy schedules. It was believed that the online discussion forum would allow teachers to receive the professional and social support necessary to engage in new teaching practices. During the first year it was assumed that the teachers would want to employ the capabilities of the online forum purely for its affordances as a discussion tool. When this proved insufficient, in preparing for the second year of the project, purposive actions were taken to provide teachers focus and guidance.

Looking back over the second year of the project, the question of whether online discussion supports teachers' professional development remains largely unanswered. An examination of the TMTP teachers' online participation in light of Riel and Levin's (1990) framework points to the teachers' lack of sense of responsibility to the group or networking tasks as a major reason for the online discussion forum's lack of success. How could the TMTP instructors have responded to this lack of sense of obligation? Had more teachers enrolled in the project for college credit, online participation could have been mandated by formally evaluating such participation as part of the course grade and requiring so many posting per week. Prior research suggests, however, that while online participation can be increased through the use of external motivators, participation under such conditions is often viewed as nothing more than busy work (Barab, MaKinster, Moore, & Cunningham, in press; Vrasidas & McIssac, 1999). As a goal of the TMTP is to foster a collegial environment in which reflection and discussion is

valued and teachers are treated as professionals, "forced" online participation is not a worthwhile option.

One response to the lack of online participation could be to place blame on the teachers for not valuing professional development focused on the building of a community of learners or, perhaps, professional development in general. Teachers' positive engagement with colleagues in face-to-face meetings, however, suggests that TMTP teachers did in fact value the building of collegial relationships. The six Cohort 2 teachers who attended as a group came from a professional development school. Several of these teachers were supervising student teachers and engaging in another professional development project being offered by the university at the same time they were engaging in the TMTP.

Instead of blaming TMTP participants for the lack of online engagement, we argue that the teachers' concerns about not having enough hours in the day are very real and need to be taken into consideration. Given everything that is required of teachers in general—and many of the TMTP participants in particular—it is perhaps not surprising that online professional development did not come to be viewed as part of the daily life of a teacher. As it now stands, teachers who choose to engage in meaningful professional development are often giving up their own time to go "above and beyond" the requirements of their jobs to improve themselves professionally. The most expertly designed online discussion forum may still not receive significant use if professional development is viewed as an add-on to teachers' busy lives and not as an integral part of their professions. As one Cohort 2 teacher responded, when asked how the online component of the TMTP could be redesigned or improved to encourage increased participation, "I don't know how to add time to my schedule."

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Appendix 1. Follow-up session activity (Winicki-Landman, 2001).

SEARCHING FAMILIES SHEET 1B

1. Solve the following systems of linear equations:

i) $\begin{cases} x + y = 2 \\ 3x + 5y = 8 \end{cases}$ ii) $\begin{cases} 3x + 4y = 7 \\ 11x + 18y = 29 \end{cases}$ iii) $\begin{cases} 5x - y = 4 \\ 3x + 7y = 10 \end{cases}$

2. Before you solve the following systems of linear equations, what do you think that their solutions will be?

i) $\begin{cases} -7x + 5y = -2 \\ 4x + 5y = 9 \end{cases}$ ii) $\begin{cases} 8x - 2y = 6 \\ 10x + 14y = 24 \end{cases}$ iii) $\begin{cases} 5x - y = 4 \\ 5x + 2y = 7 \end{cases}$

Solve the systems.

3. Suggest a new example of a system of linear equations with the same pattern.

$\begin{cases} \_\_\_\_\_ \\ \_\_\_\_\_ \end{cases}$ $\begin{cases} \_\_\_\_\_ \\ \_\_\_\_\_ \end{cases}$ $\begin{cases} \_\_\_\_\_ \\ \_\_\_\_\_ \end{cases}$

4. What do you think would happen if you graphed each pair of equations?
Make conjectures on the basis of your findings in questions 1 and 2, and prove them.

5. Using the representation of a straight line as $ax + by = c$, complete the following statement:
If the coefficients a, b, and c are consecutive terms of a Fibonacci-like sequence, then
_____.

6. Write the converse of your statement in question 5:
If _____,
then _____.

7. Before you verify the validity of the new statement, consider the line with equation $x = 1$ or the line with equation $y = 1$. Are they counterexamples?

8. Decide whether the new statement is true, and justify your decision.

9. Does a similar relationship exist for the straight lines with equations of the form $ax + by + c = 0$, where the coefficients a, b, and c are consecutive terms of a Fibonacci-like sequence, that is, where $a + b = c$?

From the *Mathematics Teacher*, September 2001

Appendix 2. Follow-up session activity (Winicki-Landman, 2001).

SEARCHING FAMILIES SHEET 2A

1. Within each family, do you see a pattern among the coefficients of the quadratic functions?

Family A	Family B	Family C	Family D
$y = x^2 + x + 1$	$y = 2x^2 + 2x + 2$	$y = -x^2 - x - 1$	$y = -4x^2 - 4x - 4$
$y = x^2 + 2x + 3$	$y = 2x^2 + 3x + 4$	$y = -x^2 + 1$	$y = -4x^2 - 3x - 2$
$y = x^2 + 3x + 5$	$y = 2x^2 + 4x + 6$	$y = -x^2 + x + 3$	$y = -4x^2 - 2x$
$y = x^2 + 4x + 7$	$y = 2x^2 + 5x + 8$	$y = -x^2 + 2x + 5$	$y = -4x^2 - x + 2$
$y = x^2 - x - 3$	$y = 2x^2 - 2$	$y = -x^2 - 3x - 5$	$y = -4x^2 - 6x - 8$
$y = x^2 - 1$	$y = 2x^2 + x$	$y = -x^2 - 2x - 3$	$y = -4x^2 - 5x - 6$
$y = x^2 + \frac{1}{2}x$	$y = 2x^2 + \frac{3}{2}x + 1$	$y = -x^2 - \frac{3}{2}x - 2$	$y = -4x^2 - \frac{9}{2}x - 5$

2. What do you think would happen if you graphed each family of quadratic functions? For each family, use a separate sheet of graph paper to graph its members on the same axes.

3. Make conjectures on the basis of your findings in questions 1 and 2.

4. Check your conjectures with new examples.

5. Describe the relationship that you found, and prove it.

6. Formulate the converse of the result that you previously found, and verify its validity.

From the *Mathematics Teacher*, September 2001

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