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Case study of online workshop for the professional development of teachers

Shu Ching Yang *, Shu Fang Liu

*Graduate Institute of Education, National Sun Yat-Sen University, 70 Lien-hai Road Kaohsiung 80424,
Taiwan ROC*

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Abstract

The study investigates the value and effectiveness of online workshops as a tool for creating professional learning communities. The pattern of interaction, mentoring quality and attitude of teacher toward participation in a Web-based Teacher's Professional Development Platform were addressed. One hundred and twenty eight participants were co-mentored by three senior elementary mathematics teachers to meet a professional development requirement. Data collection involved content analysis and supplemental surveys. The content analyzed included the participants' message posts, the quality of the dialogue and the quality of mentoring by assistants. A survey was administered to elucidate participants' attitudes towards and perceptions of the Web as a tool for professional development.

The study revealed that most participants claimed to have benefited emotionally and intellectually from using telecommunications networks for professional development and support. Positive learning effects on members were satisfactory, yet their participation was not highly interactive or as reflective as the authors would have wished. Closely examining the messages posted by participants revealed that the categories general introduction and organization were most, with the fewest associated queries and responses. The assistants' mentoring strategies mainly included feedback/praise, directing, modeling, questioning, cognitive elaboration and efforts to explore accounted for less than 10% altogether. That is, the assistants focused more on social and organizational functions, and less on intellectual function. The study was significant in that the computer-mediated workshop nurtured the teachers' professional growth, but their participation was neither highly interactive nor and, even though there much anecdotal evidence supported the claim that members enjoyed and valued the online workshops. The paper concludes by offering some recommendations concerning the future design of technology in professional learning.

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* Corresponding author. Fax: +886-7-5255892.

E-mail address: shyang@mail.nsysu.edu.tw (S.C. Yang).

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1. Introduction

Teacher professional development (TPD) and in-service training have attracted increasing interest in recent years. Faced with rapid change and demands for high standards, teachers must become involved in continued learning to become more effective in today's schools. As the complexity and interdependency of professions increase, educators must keep abreast of emerging knowledge, and be prepared to use it, continually refining their conceptual and craft skills to become more competent (Cervero, 1988; Guskey, 2000; Houle, 1980). In response to the increased expectations on schools, Corcoran (1995) urged teachers to "deepen their content knowledge and learn new methods of teaching". He claimed that "they need more time to work with colleagues, to critically examine the new standards being proposed and to revise curricula. They need opportunities to develop, master and reflect on new approaches to working with children." (p.1)

In Taiwan, continued professional learning has been incorporated into the formal structure of the teaching profession for licensure, promotion or certification. Teachers are required to participate in 30–36 h per year of in-service professional development before they are able to renew their licenses. The most common mode of professional development comprises formal training activities provided in single or half-day workshop session led by an expert who introduces teachers to new practices or teaching strategies. Other training is given in form of conferences at a university for days, or even several weeks and months. The shortcomings of such development include the time and money required to travel to the site of the workshop; the artificiality of professional development conducted outside the classroom; the logistical problems of attempting to support changes in the practice of teachers who have returned to their schools, and the difficulty of trying to keep teacher training current in a discipline such as mathematics, in which knowledge and practice evolve rapidly. Furthermore, conventional forms of professional development have been criticized as being fragmented, excessively top-down and too isolated from school/classroom realities to have a strong effect on practice; they have also been claimed to lacking in focus and do not focus enough on a particular area of teaching discipline. Furthermore, follow-up sought by teachers were often not present.

Real concerns about the effectiveness of professional development practice accompany recognition of the importance and problems of professional development. Accordingly, by leveraging the growth and power in information technology, Web-based PD provides opportunities for traditional PD that would otherwise be prevented by geographic and professional isolation, time, financial resources, and the irrelevance of aspects of conventional PD to rural teachers (Harvey & Purnell, 1995; Kendal & Rye, 1996; Putt, Henderson, & Patching, 1996). The tools and resources generated on the internet network (including for example, conferencing, white-

boards, streaming and “plug-in” technologies) provide great opportunities for enabling and energizing PD. Computer conferencing is an effective medium through which teachers can share expertise, try out new ideas, reflect on practices, develop new curricular ideas and, most importantly, develop an online learning/teaching community. Learning communities have been used effectively to promote thoughtful educational practice by allowing teachers to engage in discourse with teacher educators and other teachers in a non-threatening manner (Harrington & Hathaway, 1994). Such communities help to develop norms of collegiality and cooperative problem-solving (Harasim, 1987) and promote the growth of reflective discourse (Dickson, Franklin, & Hill, 1987; Harrington, 1991). The advancement of collective knowledge to participate in what Scardamalia and Bereiter (1991) call knowledge-building, is thus promoted. This knowledge-building environment is an effective means of advancing the status of the teaching profession (Seashore, Kruse, & Bryk, 1995). Teachers’ participation in a knowledge-building community has been envisaged to facilitate the development of subject matter and pedagogical content knowledge.

Network-mediated PD activities represent an ideal mechanism by which to implement cognitive apprenticeship, as outlined by Collins, Brown, and Newman (1989). Such activities include modeling, coaching, scaffolding and fading, articulation, reflection and exploration. Inexperienced teachers in a community may collaborate with experienced teachers; work with experts and online resources, and share, explore and learn as part of a ‘reciprocally cognitive/social apprenticeship’ network, using which multiple “zones of proximal development” (ZPD) may be established. The establishment of these zones is facilitated by suitable Internet-based activities, resources, opportunities and practices that support the social interactions of teachers and expert practitioners. Accordingly, the pre-service teacher engaged peripherally, undergoes gradual enculturation into a community of teaching practitioners. They develop reflective and critical thinking about teaching and learning, in light of the best practices and teaching standards.

2. Research questions

Taiwan’s Digital School (DS) was established to support online K-12 Teacher Professional Development. At the core of the online TPD center is a platform-independent, Web-based, real-time environment designed to satisfy the requirements of a large and diverse community of education professionals. The Digital School provides the professional teaching community various online TPD activities, hosted by universities and educational organizations. Professionals design their own programs; organize study groups; take online courses; interact online with students experiment with new teaching methods, and expand their circle of colleagues by being involved in community-wide events. DS includes a powerful set of synchronous and asynchronous communication systems, and support tools (such as online chatting, non-restricted asynchronous Web-based forums and Media Master, a stream-based lecturing system).

This investigation presents results related to the Professional Development Online Workshop for Mathematical Capacity (Mathematical Capacity Workshop, MCW). MCW set up between March and June 2001. This was the first workshop offered by DS to provide teachers online professional development. Three senior elementary mathematics teachers co-mentored the workshop as teaching assistants and provided apprenticeship and online mentoring to support the professional development of 128 pre-and in-service teachers of mathematics. This inquiry was exploratory, descriptive and qualitative. It seeks to answer the following questions.

- What are the interactive patterns and attitudes of teachers to participation in a Web-based Teacher's Professional Development Platform?
- How effective is an electronic mentors' scaffolding and what is the quality of interaction among participants in a Web-based professional development workshop?
- What is the value and effectiveness of online workshops as a tool for establishing professional learning communities?
- What is the impact of online TPD on the success of teachers?

The study addresses insight into teaching participants' assessments of the value and efficacy of online workshops as a tool for professional learning, and provides a basis for the empirical study of the acquisition and maintenance of professional knowledge by participants in Taiwan's Web-based professional teaching community. This study identifies many factors that are essential to delivering effective professional development programs. Insights gained in this pilot study will help educators of teachers to continue to refine intellectual tools to improve their professional growth.

3. Review of literature

Professional development programs are attracting more attention and recognition than ever before (Guskey, 1997). The introduction of a computer-mediated mentoring model into professional development activities opens a new avenue of enquiry inquiry. A growing body of literature on the application use of electronic networking to educating teachers is available. It includes, for example, reports on the use of electronic networking in professional development activities with experienced teachers (Burley, Yearwood, Elwood-Salinas, Martin, & Allen, 2001; Knapczyk, Chapman, & Chung, 2000; Muscella & DiMauro, 1995; Odasz, 1992; Ruopp, Gal, Drayton, & Pfister, 1993; Schrum, 1992; Slater, Coltharp, & Scott, 1997; Spitzer & Wedding, 1995; Topper, Gillingham, Ellefson, & Worthington, 1997; Tsui & Ki, 1996; Tsui, Wu, & Sengupta, 1996), on supporting the induction of inexperienced teachers (Admiraal, Lockhorst, Wubbels, Korthagen, & Veen, 1997; Beals, 1992; Colgan, Higginson, & Sinclair, 1999; Merseth, 1991; Selinger, 1997), on initial training (Broholm & Aust, 1994; Levin, Waugh, Brown, & Clift, 1994; Pearson, 1996, 1999; Selinger, 1996) and on the extent to which explicit course objectives have been realized in practice (Bonk, Angeli, & Supplee, 1998a, 1998b, 1998c, 2000; Hawkes, 2001; Hawkes & Good, 2000; Krajcik, 1995; Schaverien & Cosgrove, 1997; Selinger, 1998; Watson, Blakeley, & Abbott, 1998).

The contribution of telecommunications to professional development has recently been reported (Birman, Kirshstein, Levin, Matheso, & Stephens, 1997; Bliss & Mazur, 1996; Bull, Harris, Lloyd, & Short, 1989; Carmack, 1997; Casey & Vogt, 1997; Crotty, 1997; Ehrmann, 1989; Gray, 1989; Harrington & Quinn-Leering, 1995; Jegede, Gooley, & Towers, 1997; Powers & Dutt, 1997; Schlagal, Trathen, & Blanton, 1996; Yan, Anderson, & Nelson, 1997; Zorkoczy, 1989). Networking experiments have demonstrated that trust and warmth are not necessarily sacrificed in a distance-mediated setting; moreover, a telecommunications component widens the window of opportunity for interactions of high quality, and provides just-in-time support. Online communities provide a context in which participants can interact personally, socially and professionally, by sharing thoughts, seeking advice and sharing experiences of successes and problems, unmitigated by geographical distance (Caggiano, Audet, & Abegg, 1995; Harasim, Hiltz, Teles, & Turoff, 1995). Incorporating computer conferencing activities in TPD programs has also been found to provide opportunities for student teachers to engage in reflection and dialogue (Kovalchick, Milman, & Elizabeth, 1998; Russett, 1994, 1995), and to provide ongoing opportunities for the examination of pedagogical ideas (Dow & Geer, 1996; Zimmerman & Greene, 1998).

Evaluating the knowledge-building of dialogue in a Web-based environment is important in understanding how well participants engage in computer-mediated communication. Harasim (1989) first considered the process of building knowledge in collaborative learning, which involves the mutual exploration of issues, the mutual examination of arguments, agreements and disagreements, mutual questioning of positions, dynamic interaction and the synthesis of ideas (Harasim, 1989; Kaye, 1992). Supporting the communicative potential of the online environment, Mason determined that the shortcomings or difficulties of fostering online student dialogue converge toward synthesizing rather than diverge away (Mason, 1993; Sorensen & Takle, 1998).

Sorensen and Takle, 1998 examined the quality of electronic dialogue among students, using Stahl's (1999) criteria to characterize the quality of the KB process, which involves the following:

- **Brainstorming:** introduces new ideas concerned with the topic or task and provides a perspective not previously considered;
- **Articulating:** explains complex or difficult concepts;
- **Reacting:** provides an alternative or amplified perspective of a concept previously introduced by a student;
- **Organizing:** assembles existing thoughts or perspectives such that a new perspective emerges;
- **Analysis:** compares or contrasts previously articulated perspectives or derives new understandings from existing data;
- **Generalization:** takes comments or data that are already available and extracts new information or knowledge that applies to a broader set of conditions than that previously extracted.

Sorensen and Takle (1998) found that more carefully composed essay-like comments of increased quality and length, suffered a lack of spontaneity and "social"

elements of interaction. They concluded that electronic comments inhibit the evolution and practice of a spontaneous and dynamic dialogue.

Bodzin and Park (2000) analyzed patterns of computer-mediated communication among 32 preservice science teachers on a public Web-based forum. They proposed categories for analyzing student discourse (experiences, science, teaching, support, concern, resources, recognition), reflective discourse (perceptions, focused questions, peer scaffolding) and peer/instructor scaffolding (guidance and feedback, general advice, modeling pedagogical practices). Their results showed that the participants could engage in scaffolding pedagogical ideas with each other by sharing the perceptions of their peers. They also determined that a saturation effect occurs in discourse among large groups of pre-service teachers who responded to one particular forum posting. They suggested that a large amount of structure is required to enable students effectively to discuss science-related pedagogical issues on a Web-based forum.

Bonk, Angeli, Malikowski, and Supplee (2001) considered how to use the Web to foster collaboration and interaction among preservice teachers in undergraduate educational psychology. The preservice teachers conversed electronically with peers, mentors and instructors on the Web, about their early field experiences. Mentors used 12 forms of electronic learning assistance in responding to the students. These were social/cognitive acknowledgement, questioning, direct instruction, modeling/providing examples, offering feedback/praise, structuring cognitive tasks, cognitive elaboration/explanation, encouragement to explore, fostering reflection/self-awareness, encouraging articulation/prompting dialogue, general advice/scaffolding/suggestions and management (via private e-mail or discussion). They found that students submitted most of their cases to secondary-school conference, while fewer than 10% of the cases were submitted to the general-case conference, implying failure to perceive the generalizability of field experiences. Transcript analyses showed that students failed to justify most of their comments. Peer feedback was extremely conversational and opinionated, whereas instructor mentoring was focused on high-level questioning, offering examples and giving case-specific feedback.

4. Method

4.1. Context of this study

4.1.1. K12 Digital School

Providing students of grades K-12 rich learning environments is a high priority for the Ministry of Education in Taiwan. DS, the Web-based Learning Center at Sun Yat-sen University, was established to support Taiwan's Ministry of Education's nine-year Joint Curricula policy on lifelong professional development and technological integration. DS aims to provide K-12 teachers a platform and tools for integrating technology into their teaching and learning. In particular, DS seeks to

establish online teaching professional communities that provide a nurturing, creative and technologically rich learning environment. By constructing professional social networks, developers of these systems hope that teachers will share domain knowledge and practical experiences from various schools throughout Taiwan and the world, to activate more strongly the double-loop learning cycle in the inter- and intra-organizational context.

A set of online workshops or seminars in 2001, organized by DS and the Bureau of Education of Kaohsiung City Government, was the starting point for providing professional development opportunities. Each workshop was developed and conducted by experts in the field of education or by senior teachers/practitioners who were invited, or who volunteered, to design the learning content and activities. The online workshops were supported by a website, <http://ds.k12.edu.tw>. The DS website provides information about the workshops for K-12 students and the teaching professional community, information about workspaces for groups, online class application forms, streaming video and tool download information. All online interaction was controlled; users accessed DS using a browser and a password. DS hosted threaded discussions (asynchronous), live chats (synchronous) and files for downloading or uploading. All communications and contributions were stored and tracked for analysis at the end of the semester. Staff at Sun Yat-Sen's Web-based Learning Center coordinated the workshops.

4.1.2. Professional development through MCW

The Mathematical Capacity Workshop was designed to promote teachers' professional development. A series of 15 weeklong workshops based on the theme of mathematical capacity constituted the core of this online mathematics workshop. Two of face-to-face lectures, were provided to give the participants opportunities to become familiar with each other. The workshops had the explicit goal of improving the quality of pre-serving and serving teachers' repertoires of substantive knowledge of mathematics capacity and integrative curricula.

Each participant in MCW was required to post at least one message each week to the Discussion Forum. The Discussion Forum is embedded in DS, which can be accessed by anyone with a connection to the website. A user must have a registered account and password to be allowed to post messages to the forum.

The Discussion Forum of the Mathematics Capacity Workshop was structured to cover discussion topics on teaching mathematical content, incorporating worksheets into the curriculum and general pedagogy (including integrated curricula, for example). The online forum software allows only instructors or teaching assistants to manage the discussion forum by setting the timeline and designating new topics or themes for discussion, to maintain the structure of the discussion. A user may post a new message, reply to a message or send a message with attached files with a two-megabyte limit. When users first enter a topic area, they are presented with a list of messages and reply titles. Each message and reply title displays the author's name and the date on which message were posted to the forum. The most recent message is at the top of the list. Each message and reply title is a hypertext link. The user clicks on a message or reply title to view the posted message. Replies to messages can be

organized thematically, enabling users to read an entire thread of successive replies to the original message. Replies to messages can also be arranged chronologically with the newest reply at the bottom of the message thread, which ordering reflects the natural flow of a face-to-face conversation and reflects the organization of a bulletin board system.

4.1.3. Instructional design

Three senior elementary mathematics teachers were online mentors to support the professional development in mathematics of pre-and in-service teachers. They were responsible for designing the course; co-moderating the weekly asynchronous (Web discussion) and synchronous (chat sessions) discussions and grading assignments. One teacher gave video lectures using a stream-based lecturing system (Media Master), a three-in-one system that includes a browser and a stream-based recorder and player. Participants can access the Web-based audio and video streams synchronously in real-time, without having to download large files.

The online workshop was implemented in two parts: online asynchronous instruction accompanied by face-to-face lectures over three weeks. Collaboration and discussion were incorporated into the online course. Online asynchronous learning involved weekly discussion on specified themes. The first week was used to acquaint teachers with workshop members and also to familiarize them with the website environment, its features and tools and the course syllabus. In the eighth week, members attended a curricular seminar, and the final week included a closing ceremony. The remaining 12 weeks included themed discussions, group chat activities and individual and group projects.

4.1.4. Curriculum design

MCW included 11 units; these were design philosophy, course philosophy, the concept of ‘capacity’, cognitive structure, the structure of materials on capacity, analysis of materials on capacity, instructional design, instructional activity, worksheets and parent–child interactive play. Learners were required to browse the on-line-materials and then discuss them on the discussion board. Additionally, every Friday from 9–10 A.M., participants attended a chat session on a discussion topic designated by the teaching assistants.

4.1.5. Evaluation

Individual assignments were evaluated. These included at least one weekly assignment completed by each student, one individual final report and three group projects, including worksheets for parent–child interaction, instructional designs, and other deliverables. A PD certificate was issued according to involvement in the workshop and the number of hours spent. Notably, the participants did not necessarily accomplish all of the required tasks mentioned above, but they meet the basic requirement of accumulating a total of 10 h. When a participant met this requirement, the certificate, documenting workshop hours, was presented at the end of the course.

4.2. Participants

Originally, a total of 165 participated in the workshop; however, 128 teachers who fulfilled the basic requirement of accumulating 10 h, and thus obtained certification, were considered herein. The participants were from various schools from diverse regions of Taiwan. Three fifths were from Kaohsiung. Their ages ranged from 21 to 43 (overall mean = 26.4 years). Most of participants were primary school teachers who had (previously participated in professional development workshops. However, none of the participants had experience of an online professional development tool. All participants were given accounts to access the online PDA tools. The activities instructor, during a class meeting before the online unit began, taught the teachers how to access and use the functions of the tools. The three assistants were senior primary school teachers and are Supervisors of Instruction in Mathematics.¹ They had extensive experience in organizing traditional face-to-face workshops, but this was their first involvement in online workshops for professional development.

4.3. Procedure

The first session of the online mathematic workshop was held between March and June 28, 2001. Participants accessed online activities using a personal username and password. They were given a 50 min training session in January. In the training session, they learned about important online K-12 DS features (including for example, using the reply button, the displaying teaching content in Web master, adding personal profiles, starting or replying to new dialogues, sending attached files, uploading electronic assignments and initiating chat room dialogues). Additionally, participants had opportunities electronically to read and discuss issues associated methods of teaching mathematics. These training sessions helped to ensure that participants had clearance to access the system and knew how to do so. The warm-up activity was to post a biography to the course bulletin board, to acquaint them with class members and familiarize them with the website's features.

4.4. Data collection and analysis

This study investigated the participation and perspectives of 128 teachers engaged in online professional development activities in the area of teaching mathematics. The research involved content analysis questionnaires and brief interviews over e-mail. All asynchronous/synchronous discussions and PD activities were saved and archived for later in-depth analysis; summary data and discussions on specific theme were printed out at the end of each conference. The summary data included the

¹ The quality of teaching has been a major concern of Taiwan's local governments. Local governments have established instructional supervision groups in various subjects (such as English, Mathematics, Science and others) by selecting senior and outstanding teachers as supervisors to improve enhance teachers' professional growth and competence.

actual number of messages posted to the Web during PD activities, and the numbers of mentors' and peers' responses to these messages as well as themed discussions. Dialogue transcripts were identified by discussion thread, dialogue content, form of mentoring by senior teachers and the degree of reflective thinking by participants. Exemplary comments, interactions and patterns of interaction were noted during this detailed analysis.

A questionnaire was given to elicit information on the participants' perceptions of, and attitudes toward, the use of online workshops for professional development. The participants were asked to describe the process of engaging in Web-based professional development. They were asked to describe the difficulties that they had encountered in the workshop, and their solutions to the problems. They were asked about the positive and negative aspects of the workshop, and to offer ideas for improving professional development activities in the future (for example, the areas of curriculum design, theme discussion and others).

4.5. Coding category

Participants' comments in online dialogues were analyzed and categorized according to the knowledge-building quality criteria proposed by Stahl (1999) and Bodzin & Park (2000) (Table 1). The scheme for categorizing how the three senior teachers moderated and promoted participants' development of professional mathematics-teaching skills was adapted from the 12 forms of electronic learning mentoring and assistance (Bonk & Kim, 1998; Bonk et al., 2001) (Table 2). Data obtained from the forum were coded and categorized by evaluating each message with reference to the type of information or communication presented, using Tables 1 and 2 as templates. Emergent categories were used to identify the types of messages and interactions.

5. Findings and discussion

5.1. Participants' accessing the online workshop

The survey found that the reasons for MCW's popularity include its convenience and focus on teachers' needs, and the prerequisites to maintaining licensure, gaining promotion or gaining certification. In this workshop, the teachers could obtain certification by meeting minimal requirements, which thus provided great flexibility to be exploited by participants according to their timetables, preferences and energy levels.

Participants participated in discussions throughout the week. Comments tended to be made everyday at 8 P.M. – midnight and 7–8 A.M.; assignments tended to be uploaded on Saturday. The day of the week on which a participant posted messages varied, as did the time when participants did not have classes. Most of the participants were teaching during daytime hours on weekdays, so fewer posted messages

Table 1
Coding of participants' comments

| Code # | Code name | Definition | Example |
|--------|---------------------|--|--|
| 1 | General explanation | Offering general advice or personal perspectives without further developing an idea in the message thread and without satisfying the criteria for any other type of message. | "In my personal opinion,...", "I think X is..." |
| 2 | Organization | Organizing of existing thoughts or perspectives | The following summarizes the materials on... |
| 3 | Question | Requesting clarify information, building on a response in the thread | What is the difference between A and B? What if...? Is X any other way to...? |
| 4 | Analysis | Comparing or contrasting previously articulated views | In contrast with..., on the one hand, on the other hand... |
| 5 | Articulation | Explaining of complex or difficult concepts | Take X for example... I have used one method..., I think this method.... When I taught in the 3rd grade,... |
| 6 | Reaction | Presenting an alternative or more detailed perspective on a concept previously introduced | I agree with..., In line with A, In reply to A |
| 7 | Brainstorming | Introducing new ideas on a topic or task and offering a new perspective | I think "X" is an innovative way of teaching, we can apply it in... Sure it is a good starting point, and I think we can |

were posted then than on weekday evenings. Participants accessed course materials from their home computers. Access from school computers was relatively limited. However, participants who did not have access to the Web from home mostly used school computers to gain access.

Participants varied widely in their degree of participation in computer conferences. For example, a small fraction of the teachers did not at all, or only rarely participated in the conferences. Some dropped out of the workshop; some wrote messages only once a week, and some sent more messages than required. On average, participants reported that they spent four and a half hours per week on computer conferences and that the time spent was worthwhile. In particular, reading messages took more time than they had expected.

DS embeds a synchronous chat feature, which can be tracked by the assistants, and participants were encouraged to use this option as they worked with their partners on their group projects, or just discussion. Numerous chat room conversations were initiated among some groups. Weekly chat room conversations were arranged on Fridays on topics such as classroom management, constructivist teaching of mathematics, changes in education, experiences of online learning and teaching, among others.

Table 2
 Categorization of mentors' scaffolding strategies

| Code # | Code name | Definition | Example |
|--------|-------------------------------------|--|--|
| A | Management | Answering questions and providing information on activities | "Recently, we held two activities; if you are interested you can roll in.. ", "For those who did not attend face to face sessions, you can watch live video on the curriculum content board" |
| B | Questioning | Posting a question regarding concepts or content | "What is the concept of an integrated curriculum? "How is this related to. . .?" "Can you justify this?" "Who can tell me. . .?" "What is the real problem here. . .?" |
| C | Direct instruction | Directly introducing a concept, some content, specific framework or objectives | "Remember the first week of the semester when we went over "X" which indicated that. . .", "So-called "X" indicates. . ." |
| D | Modeling/exemplifying | Augmenting an idea by illustrating a pedagogical practice or a specific example | "We can implement this innovative way of teaching using the method of. . .", "That video we saw on "X" is good example of teaching. . ." |
| E | Feedback/praise | Statements referring to support and praise (i.e. giving feedback and praise, and supporting one's ideas) | "Wow, I'm impressed. . ." "That shows real insight into. . ." "It is fantastic. . ." "Thanks for responding to "X". . .," "I have yet to see you or anyone mention. . ." |
| F | Cognitive elaborations/explanations | Asking focused questions to build on ideas presented in the message thread for clarification | "I am not quite sure what you mean; you might elaborate it more. . .", "Provide more information here that explains your rationale," "Please clarify what you mean by. . ." "I'm just not sure what you mean by. . .," " |

| | | | |
|---|---|---|--|
| G | Push to Explore | Pushing learners to provide, search or look for sources of information | “You might go on the X website for more information. . .” “You might want to write to Dr. “XYZ” for. . .,” “You might want to conduct ERIC search on this topic. . .,” |
| H | Fostering reflection/self-awareness | Challenging learners to think deeply and stimulating constructive reflection by learners as they conjecture, probe and contemplate issues | “Where have you seen this before. . .,” “When you practice this theory in class teaching, you should consider. . .” “Restate what the teacher did here. . .,” “Describe how your design/teaching will vary from this. . .,” “How might an expert teacher handle this situation. . .” |
| I | Encouraging articulation/dialogue prompting | Inspiring students to offer opinions, and triggering cognitive conflicts to spur deep thought or dialogue | Does anyone have a counterpoint or alternative to this situation. . .,” (NOTE – a situation doesn’t have a counterpoint – a position or argument or point does) “Can someone give me three good reasons why. . .,” “It still seems like something is missing here; I just can’t put my finger on it. . .” |
| J | General Advice | Offering general advice. It can be the first message in a message thread in which no scaffolding is provided posting | “If I were in her shoes, I would. . .,” “Perhaps I would think twice about putting these kids. . .,” “I know that I would first. . .,” |

Someone engaged in synchronous chat can record all conversations on her/his own computer. The chat server can also be set to record all discussions. Participants can log everything that was said for later review. The logs can even be distributed to participants to reflect on, after the discussion is over. Frequently, these records contained information such as the time when each comment was received by the server. They are thus a valuable source of information for researchers and teachers.

Some participants visited the chat rooms to see how they were designed but did not view the feature as an appealing option for group or course-related communication. These group members tended to collaborate over e-mail, supplemented by face-to-face meetings and telephone conversations. Some were enthusiastic about the chat rooms for sharing teaching ideas or considered them to provide a good outlet for socializing during online meetings. However, when several conversations were being conducted in various rooms, following in individual threads was difficult. This study found that, after two online chats, participants volunteered to summarize the chat transcripts and post them on the board for the reference of other members. We do not address these chat dialogues in this study.

5.2. Patterns of interactive messages

The total number of messages posted by teachers and assistants in each week was analyzed to elucidate patterns of computer-mediated communication in asynchronous discussion forums. Table 3 reveals that, over a 15-week period, participants posted (a total of 2403 messages on the bulletin board. Topics included weekly themed discussions ($n = 1666$), curriculum discussions ($n = 494$), course information ($n = 175$) and course announcements ($n = 68$). Of the 1666 messages posted during a weekly themed discussion, 1595 (95.74%) were associated related to) the weekly theme; the rest, 71(4.26%) were unrelated, being for example, simple procedural, social and technical posts. Procedural posts contained announcements, logistical information or information about requirements, to remind participants which materials they had to read and which tasks they had to complete during the week.

Relatively few posts were related to technical issues. Enquiries or questions on transmission and access problems or server breakdown tended to be sent to the system manager or an assistant. Fewer social acknowledgement posts were noted herein than in most other CMC studies, which finding might be explained by the availability of other channels for socializing in the workshop, including two face-to-face conferences, weekly online chats and group activities. Furthermore, the participants could initiate group chat-room conversations at anytime by sending messages to users presently using the website online.

Table 3 presents the variability in the discussion topics by the participants. Some topics were discussed less than others; a particular fall-off was observed in the final two weeks ($A14 = 67$, $A15 = 71$), perhaps because the end of the course was being approached, and participants were busy completing their projects. Table 3 indicates that the number of posts by participants averaged 95.6; the number of peer responses

averaged 4.9, and moderators posted an average of only 4.76 messages per week. The fact that the total number of replies (by participants and mentors) represented under 10% indicated that few participants and assistants responded to each other. According to Moore (1989), distance education involves three styles of interaction, which are learner–learner, learner–instructor and learner–content interaction. The results indicated mostly learner–content interaction, with minor amounts of learner–learner interaction and learner–instructor interaction.

Close examination of message contents revealed numerous stand-alone messages, either in response to others, or weaving two or three replies; generally, however, stand-alone messages were mostly monologues. Furthermore, most replies were single replies to messages; most discussions failed to proceed beyond a question and a single reply. Participants tended to post to state their opinions on an issue, but they were unresponsive to the postings of their peers. Only a few parties maintained conversations over many exchanges. In other words, participant interactions were more reflective of commonly one-way than two-way interactions.

Holt, Kleiber, Swenson, Rees, & Milton (1998) identified six stages of deliberation in forums, including two stages of pre-deliberation, two stages of quasi-deliberation and two stages of deliberation. The pattern of communication noted in this study appeared to reflect only Holt's pre-deliberative stage. That is, participants found common ground by learning about issues and sharing their personal interests, beliefs and values, tending to use first-person language and declarative, assertive syntax, while others, eliciting personal opinions and promoting conversation, wrote in terms of "you and me" and "us and them".

Although one may argue that some participants did not contribute significantly to online discussions, many participated as "vicarious interactors", as Sutton (2001) called them. That is, they cognitively processed content while absorbing the interactions of others and used the discussion board and assignment areas to obtain lesson ideas and assistance. However, the purpose of a teaching professional development (TPD) virtual community is to provide teachers opportunities to participate in professional communities; to access and discuss exemplary models and materials; to co-construct, review and publish resources that reflect their beliefs and teaching practices, and jointly to generate relevant solutions and practices. Such a teaching community should be designed to support collective intelligence and the meeting of minds via interactive and reflective dialogue. In a discussion like this, goals such as exploring multiple perspectives or developing shared understandings cannot be expected to be attained; therefore, increasing the effectiveness of discussions within the forum is important.

The participants attributed the poor number of responses to a lack of time, the need to complete too many assignments, the need for more clues in the messages, the fact that the discussion topics were not very likely to generate questions and reactions and the statement of too few experiences that matched those of the readers. Consider, for instance, the themes: some topics appeared to be self-absorbed utterances that did not invite discussion or exchange. Moreover, some participants, with zero to three years of classroom teaching experience, pointed out that they lacked a base of experience and knowledge from which to evaluate and discuss ideas for

classroom implementation. New teachers who had neither the time nor maturity of judgment appeared to need extra scaffolding to enable them to take full advantage of the various resources provided by the workshop.

5.3. Analysis of dialogues during weekly themed discussion

Participants' comments made during online dialogues were categorized for analysis according to the knowledge-building quality criteria of Stahl (1999) and Bodzin & Park (2000). The scheme for categorizing how the three senior teachers moderated and promoted the development of participants' professional mathematics skills was adapted from the 12 forms of mentoring and assisting electronic learning (Bonk & Kim, 1998; Bonk et al., 2001). Table 4 presents the distribution of participants' messages by category over 15 weeks of posting; most messages are in general introduction and organization categories (49.2% and 26%, respectively), whereas queries and response messages only constitute 3.2% and 3.8%, respectively, of all messages. The distribution among categories may be related to the themes of discussion, since the 15 weekly themes could be divided into two types: capacity mathematics (i.e., A3, A7) and K-12 teaching. The participants related more organization categories to the discussion of capacity mathematics (i.e., A3, A7) since capacity mathematics has its own conceptual framework, whereas they engaged more in general introductory topics in the area of K-12 teaching (A5, A6). Moreover, the ninth, tenth and 13th weeks saw the posting of more analyses, involving the contrasting and comparison of perspectives presented in participants' dialogues, which finding was also related to the themes of the discussions in those weeks.

5.4. Analysis of assistants' scaffolding and interactive quality

The frequency with which teachers and assistants posted messages was calculated every week to understand how assistants moderated participants' discussions to promote their professional growth. The categories in Table 2, identifying assistant scaffolding strategies embedded in electronic discussions, were adapted from Bonk's 12 forms of electronic learning mentoring and assistance (Bonk et al., 2001). Table 5 reveals that the assistants primarily used feedback/praise strategies ($n = 52$, 42.97%), followed by general advice ($n = 21$, 17.35%), management ($n = 17$, 14.16%), fostering reflection ($n = 11$, 9.09%) and encouraging articulation ($n = 7$, 5.78%), while directing, modeling, questioning, cognitive elaboration and encouraging effort to explore altogether accounted for under 10% of all scaffolding instances.

Of the three assistants, M1 posted 47 messages; M2 posted 55 messages, and M3 posted only 18 messages during the conference workshop. Of the 11 posts that fostered reflection, M2 wrote 10 posts to foster participants' reflection and self-awareness, in contrast to M1's single post and M3's absence of any such. Of 52 feedback/praise posts, M2 provided 32, while M1 provided 11 and M3 nine. Of 17 management posts, most of M1's were concerned with organizing and managing conferences; M2 wrote two posts, and M3 wrote none. In summary M1 tended to rely on management (32%), feedback and praise (23%), direction, prompting

Table 4
Quality of dialogue by category

| Category week | General introduction | Organization | Question | Analysis | Articulation | Reaction | Brain storming |
|---------------|----------------------|--------------|----------|----------|--------------|----------|----------------|
| A1 | 58 | 20 | 8 | 27 | 12 | 2 | 11 |
| A2 | 64 | 32 | 6 | 6 | 15 | 6 | 9 |
| A3 | 15 | 92 | 8 | 14 | 11 | 5 | 3 |
| A4 | 48 | 43 | 6 | 12 | 17 | 8 | 4 |
| A5 | 78 | 0 | 3 | 13 | 0 | 2 | 0 |
| A6 | 76 | 0 | 9 | 3 | 1 | 7 | 3 |
| A7 | 19 | 90 | 3 | 13 | 6 | 9 | 4 |
| A8 | 71 | 8 | 2 | 3 | 12 | 4 | 16 |
| A9 | 38 | 24 | 0 | 46 | 2 | 2 | 1 |
| A10 | 44 | 34 | 0 | 30 | 3 | 0 | 2 |
| A11 | 50 | 34 | 2 | 12 | 10 | 3 | 10 |
| A12 | 60 | 30 | 2 | 8 | 11 | 0 | 5 |
| A13 | 67 | 5 | 1 | 25 | 3 | 6 | 2 |
| A14 | 51 | 1 | 0 | 11 | 0 | 1 | 3 |
| A15 | 46 | 2 | 1 | 8 | 1 | 6 | 14 |
| Total/average | 785/52 | 415/27 | 51/3 | 231/15 | 104/7 | 61/4 | 87/6 |
| Percentage | 49.2% | 26% | 3.2% | 14.5% | 6.5% | 3.8% | 5.5% |

Table 5
Distribution of scaffolding by assistants

| Teaching assistants scaffolding techniques | # of postings by M1 | # of postings by M2 | # of postings by M3 | Total (%) | Rank |
|---|---------------------|---------------------|---------------------|------------|------|
| Management | 15 | 2 | 0 | 17 (14.16) | 3 |
| Questioning | 1 | 0 | 1 | 2 (1.65) | |
| Direction | 5 | 0 | 0 | 5 (4.13) | |
| Modeling/examplng | 3 | 0 | 0 | 3 (2.47) | |
| Feedback/praise | 11 | 32 | 9 | 52 (42.97) | 1 |
| Cognitive elaboration/explanation | 1 | 0 | 0 | 1 (0.82) | |
| Pushing to explore | 0 | 1 | 0 | 1 (0.82) | |
| Fostering reflection/self-awareness | 1 | 10 | 0 | 11 (9.09) | 4 |
| Encouraging articulation/dialogue prompting | 5 | 1 | 1 | 7 (5.78) | 5 |
| General advice | 5 | 9 | 7 | 21 (17.35) | 2 |
| Total | 47 | 55 | 18 | 120 (100) | |

dialogue and general advice (each 11%). M2 resorted more to feedback and praise (58%), fostering reflection and offering general advice (18% each). M3 offered more feedback and praise and general advice.

Paulsen (1995) described three essential functions of computer conferencing moderators, including organizational, social and intellectual functions. This study revealed that although the assistants' mentoring styles varied widely, all of the assistants used most of the social and organizational functions. M1 used more organizational functions, and M2 adopted more social, and some intellectual functions. The assistants established a friendly, social environment, encouraging participation throughout, and offering much feedback and praise. They also structured and managed the conferences, setting the agenda (including the objectives of the discussion, the timetable and procedural rules). The assistants focused more on the social and organizational functions, and less on intellectual functions. Thus, the fact that moderators used various modes of communication to nurture collegial relationships, and reflective conversations, is very important.

5.5. Learners' perceptions of the online workshops

Results show that most learners generally found their experience of the project to be positive, rewarding, constructive, empowering, exciting and challenging. They were delighted by this type of learning and suggested that it be incorporated into other professional development activities. They felt that they had benefited from the workshops and from learning together in a virtual environment. Though some disagreed, most participants felt that online workshop conferencing tools contributed to their professional development. Most mentioned that the Web-based workshop helped them clarify mathematical concepts, deepened their understanding of children's cognitive development and capacity; helped them to develop multiple ways of thinking about mathematical instruction and teaching, and gave them opportunities to learn about innovations in practice, new resources and skills. A couple of insightful teachers noted that they tended to have more mathematical discussions with their colleagues, and reflected more on teaching and mathematical issues after the workshop than they did before it.

The survey revealed that most participants agreed with various statements that expressed satisfaction with the online workshop. They were positive about their gains in facility with computer technology, making new acquaintances, learning about the development of children's mathematical thinking, expanding their knowledge base, and other areas. Moreover, some teachers claimed that the workshop was valuable in increasing their technological competence, overcoming a fear of technology, and improving typing skills, since the workshop explicated new ways of integrating technology into teaching practice.

When asked for advice on improving the workshop, participants suggested the following; provide more resources and teaching demonstrations, increase the number of face-to-face seminars, invite more senior teachers and professors online, give assignments according to the teaching workload, and establish more mentors. Dozens

of specific suggestions associated with the interface, curriculum and instructional design, were also offered. For example, the workshop provided 8–10 min long video-based “anchors”, which accompanied the learning materials, to encourage teacher discussion. Participants commented that the live video sessions helped the participants to feel that they were connected to the expert, but that they felt that the learning content was not sufficiently rich to provide scaffolding for their understanding of the theoretical framework of complex issues. Moreover, video was not smooth and sometimes the slow transmission resulted in very irritating time lags. They stated they would have appreciated the video sessions’ being made available on CD-ROM and a richer content on mathematical theory and instruction. A CD-ROM could be watched at the convenience of the participants, who could also thus reduce Internet connection time.

Although some activities related to the weekly themed discussions provided new ideas for viewing and solving problems, some participants claimed that they would have benefited greatly from reading the themed threads, or writing on themes that were directly related to the theory and practice of teaching mathematics. They recommended that the theme of each discussion be more closely related to the teaching and practice of mathematics supplemented by actual teaching demonstrations to provide coaching and modeling.

The number of teaching assistants was limited, and some mentioned that they were a little disappointed with the minimal feedback they received from peers and mentors, although they greatly appreciated the assistants’ efforts. They suggested that a future PD should be more diversified, personalized, and more life-related; the assignments should be shorter, and the number of assistants increased to improve coaching and provide just-in-time interactive mentoring.

Participants’ perceptions of the importance of the role of assistant, and their satisfaction with the assistants were elucidated using a survey. The results showed that participants thought that moderators were important in the functioning and promotion of their professional development, and appreciated their effort. However, they noted that the quality of the mentors’ feedback could have been improved by increasing the number of assistants and the number of scholars and professors, and by increasing the frequency of lectures, to encourage teachers to be more reflective and critical. Some specifically pointed out that one or two mentors should be responsible for a group of four to six members.

A number of participants noted that they preferred technologically mediated professional development activities not only to be independent time and geography, but also to provide them with just-in-time support to give them a feeling of community. They thought that the workshop provided valuable opportunities that otherwise would have been unavailable, and that the online communication brought them in contact with distant peers, preventing them from feeling isolated. For example, some remarked that being involved in the linking of teachers all over Taiwan to discuss issues outside their own schools felt wonderful. The asynchronous format allowed for prolonged and thoughtful exchange of ideas. Despite participants’ highly valuing the Web-based professional development, they felt that traditional workshops still have value. For instance, teachers valued the give and take of good

face-to-face discussions. Moreover, they emphasized that design and technical activities (such as, computer-based learning), that are difficult to perform online still have a place in traditional workshops.

6. Conclusions and implications

This study offered pre-and in-service teachers an online professional development opportunity over the Web. The project was designed as a mentoring tool to scaffold teachers' professional development in teaching mathematics. The authors hope that master teachers, and university faculties will work together to reflect and refine the knowledge, skills and habits-of-mind, associated with theory, practice and field experience.

This project was designed to elucidate participants' perspectives of the integration of Internet tools in PD activities. Results show that most participants found that the online workshop was, useful despite some technical problems that arose from the use of this new technology. Most participants claimed that they benefited emotionally and intellectually from using the telecommunications network for professional development and support. They were positive about the DS and thought it could promote the formation and maintenance of a virtual community by its blending of synchronous and asynchronous communications tools. Despite the fact that the study was significant in that DS allowed teachers to nurture their PD through a computer-mediated workshop, their participations were not as interactive or reflective as we would have liked, even though much anecdotal evidence supported the members' enjoyment and valuing of the online workshops. Furthermore, although the positive effects on the learning by members were satisfactory, some issues remained to be further addressed and reflected upon. For example, some factors were identified as influencing teachers' online participation these should be further understood.

First, the availability and access to workshops was important. The success of the online workshop was found depend on the access to equipment and to the Internet itself; on the availability of time to plan, work and communicate, and on the prior knowledge and experience of participants. Some teachers claimed that they needed more time to manage and understand the information about the program, more time to digest materials and work on their projects, and more time/guidance to communicate with their peers. Some of them blamed themselves for over-scheduling their time, for not fully participating, for failing to complete the required preparatory tasks to ensure that they would understand the core concepts and for letting their peers and mentors down by not engaging more. Given this, a future TPD workshop should be sensitive to the demands placed on participants and care must be taken in preparing and providing essential assistance and guidance within individuals' ZPD.

Second, while teachers recognized the need for greater professional interaction, they did not offer these concerns to their online colleagues for the various reasons mentioned above. The study found that various participants sent bulletin-board-

like messages rather than conversational messages, and a small group of teachers became “lurkers”, who did not post any messages. Teachers generally did not engage in deep interactions online. Most messages appeared to be broadcast to the entire group and offered a glimpse of what the poster was doing or thinking, or they were originally intended for the moderator but were published because they were thought to be of general interest. Not much two-way interaction and sustained, in-depth dialogue was observed over the 15 weekly themed discussions. The dominance of findings of dominant monologues implied that the scaffolding required to enable participants to conduct wide-ranging deep discussion, depends on a large amount of structure.

Given that the fabric of the professional teaching community is woven from actions and interactions of individuals, and that dialogue is viewed as one of the main methods of fostering professional development and reflective equilibrium in the teaching community, sustaining reflective dialogues to promote the professional development of teachers is of paramount importance. A system designed in the future should perhaps elicit more reflection-stimulating posts by requiring participants to read and respond to peers and mentors’ postings, thereby forcing them to think and form ideas. Facilitating a change in online communication from reactive to highly interactive and reflective is hoped to lead to participants’ seeking shared understanding, as they engage in critical thinking and analysis and solving problems that concern authentic classroom experiences.

Third, the perceived helpfulness of the moderator profoundly affected the teachers’ comfort with the discussion form, and therefore, the frequency with which they used it; accordingly, an effective moderator is crucial to ensure frequent online participation. This finding implies that more attention should be paid to the structure of a student teachers’ learning environment, because more thorough coaching and instruction of teachers in the systematic and reflective use of computer conferencing, results in more varied and extensive communication. A number of studies have emphasized the importance of specific skilled moderators in promoting learning in a CMC environment (McMann, 1994, 1997; Spitzer, Wedding, & DiMauro, 1994). In this work, despite their expressions of gratitude for assistants’ socio-emotional support and their efforts in guiding their learning, participants expressed the need for more tips in the messages, since they felt unsure of their capacity to engage in sustained online communication; briefly, they required more guidance and scaffolding. Moreover, some teachers argued for the themed discussions’ being more structured and reflective of their teaching, to promote exchanges of pedagogical content knowledge, concerning mathematical instructional methods and designs, subject-specific curricula and the profession of teaching mathematics. With this in mind, future PD workshops should model more reflective practices to offer a clear link between a significant professional development activity and classroom practice. Themes should be designed to offer opportunities for participants to share information on teaching and to adopt reflective approaches to understanding classroom events and practices.

Fourth, this investigation found that teachers who posted many messages were more likely to be both interactive and reflective in their communication, which result

indicates that professional growth depends on self-directed learning, as well as an effective moderator to ensure frequent online participation (Shotsberger, 1997). A single interaction at a high level is unlikely by itself to produce long-term habits of reflection in participants (Gore, 1987), but it is a starting point for the possibility of encouraging critical reflection by sharing, evaluating, knowing, experiencing and exchanging diverse beliefs and teaching practices. Teachers will grow professionally if they are willing to take responsibility for their own self-development, and open their core values and assumptions up to analysis and reflection in a challenging and supportive context.

Fifth, the assistants focused more on social and the organizational functions, and less on intellectual function. One explanation for this finding can be offered. This study was a first attempt and senior teachers did not receive any formal training in mentoring strategies before participating in the workshop. Only three senior teachers were responsible for mentoring more than 100 participants, which tasks were certainly very challenging. In addition to their teaching daily, they had to provide just-in-time support; initiate discussions in chat rooms; comment on participant's assignments, and draw on their professional expertise to stimulate reflective dialogues. A future PD system will involve more mentors and require that moderators be trained to use various modes of communication to nurture collegial connections and reflective conversations. The PD workshop should provide an environment that encourages teachers to interact not only personally and socially, but also professionally, by sharing thoughts, seeking advice and sharing experiences of successes and failures.

Finally, reflective professional discourse must be nurtured, since it does not grow simply out of professional relationships; the sustained self-development of reflection and active learning depends on time, effort, support and initiative (Spitzer et al., 1994). The present study is only a preliminary phase on the way to providing a supportive, learning environment that provides the professional development opportunities to enable teachers to engage in exploration, research-based inquiry, reflection, experimentation and practice. Although this study highlights some shortcomings in the initial course design, the existence of these shortcomings should not be construed negatively, but, rather, as a guide to future curriculum developers and teachers who are seeking to design improved activities to foster teachers' collaboration, reflection and dialogue. Numerous studies have emphasized the importance of dialogue in helping teachers transform their teaching practices and the difficulty in sustaining continued interaction (for example, Elbaz, 1988; Joyce, Murphy, Showers, & Murphy, 1989). A future design should involve a concerted effort to refine the creative network medium by providing sufficient time, training, practice, resources, feedback and follow-up support of sustained, thoughtful and reflective dialogues about teaching practices. The authors are currently undertaking a follow-up study of the MCW participants to determine whether they have been able to apply their workshop experiences in the classroom. The authors feel that further research into these powerful network environments will broaden and hone the professional development of teachers.

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Shu-Ching Yang is a Professor at Graduate Institute of Education, National Sun Yat-Sen University, Taiwan. She received her PhD in Instructional Systems Technology at Indiana University of Bloomington. Her current research emphasis focuses on the teaching community, professional development, and the learning processes associated with various kinds of interactive technologies. She has additional articles published in *Journal of Computer Assisted Learning*, *Journal of Educational Computing Research*, *Educational Technology*, *Journal of Educational Multimedia and Hypermedia*, *Library Information Science Research* and *Journal of Interactive Learning Research*, *Journal of the American Society for Information Science*, *Computers in Human Behavior*, *IEEE Transactions on Education*, etc.

Shu Fang Liu is a teacher at Yo Chang Elementary School, Taiwan. She received her M.A. in Graduate Institute of Education, National Sun Yat-Sen University.