Computers & Education 53 (2009) 1155–1166

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

The use of online synchronous discussion for web-based professional development for teachers

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ARTICLE INFO

Article history:
Received 26 July 2008
Received in revised form 19 March 2009
Accepted 25 May 2009

Keywords:
Adult learning
Computer-mediated communication
Learning communities
Lifelong learning

ABSTRACT

This article described the experiences of an inservice professional development program for teachers with a focus on online synchronous discussions. Transcripts of six online synchronous discussions containing 3600 messages from an online teacher professional development course were analyzed. In addition, the researchers interviewed 10 participating teachers in order to understand their perceptions toward online synchronous discussions. According to the online discourse data, the online synchronous discussions served not only as a learning tool, but also an avenue for teachers to request and provide information, socialize and support each other. The analyses also revealed that the teachers posted more social messages in the beginning and the end of discussion, and most messages did not involve any cognitive and metacognitive skills. Moreover, the interview results showed that the information exchange during online synchronous discussion was not effective for some participating teachers. Based on the interview data, synchronous discussions appeared to hold little advantage when compared to face-to-face discussions for several participating teachers that we interviewed. The problem may be resulted from lack of self-regulated skills by the participants or from the role played by the moderator.

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1. Introduction

Online professional development (OPD) provides Internet-based learning opportunities, including educational courses, activities, workshops, resources, and online interactions with instructors, mentors, and colleagues (Treacy, Kleiman, & Peterson, 2002). Online professional development provides opportunities to participate in professional development activities that might not be offered locally. Designing and implementing successful professional development programs is receiving much attention in several domains such as medical field. For example, the shortage of nurses and cost constraints create challenges for nurse educators to provide the necessary professional development. For nurses, computer-based training is as effective as or more effective than traditional training methods, and a blend of the two approaches offers the most cognitive improvement (Benson, 2004).

Since the context in which teachers work is undergoing rapid change and this means that teachers need better and ongoing professional development to keep them up to date. There is growing evidence that if teachers are provided with access to ongoing professional development programs, they are more likely to be more innovative (Dede, Jass Ketelhut, Whitehouse, Breit, & McCloskey, 2006).

While many different technologies have been used to support or provide OPD, questions still remain as how synchronous online discussion may support quality and success in professional development and teacher education. With the prevalence of OPD little is known about the best practices for the design of theses OPD models. Therefore, the goals of our research were to explore the percentage and frequency of online synchronous discussion in an OTPD program in terms of social cues, interaction types, cognitive and metacognitive skills and how messages vary by different posting periods. In addition, the researchers interviewed the participants in order to find out their perceptions towards the synchronous discussions for improving the design and functions of OPD.

1.1. Online teacher professional development

The need for OTPD that can fit with teachers' schedules, that are creative and resourceful and ongoing has led to the creation of OTPD programs (National Academy of Sciences, 2007). To address this issue in current TPD programs, educators have started to utilize

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doi:10.1016/j.compedu.2009.05.026

technological tools to support both preservice and inservice TPD. Generally, these programs are available to teachers at their convenience and are more scalable than professional development that depends on local resources and face-to-face interactions (Dede et al., 2006).

Online teacher professional development offers educators an alternative opportunity for professional development. It also could overcome the obstacles such as the large geographical area and the increase in transportation problems. Moreover, OTPD makes anytime, anyplace professional development available to educators by using a range of digital resources to enhance the pedagogy of teaching (King & Dunham, 2005; Ryan & Scott, 2008). With OTPD programs, teachers are able to develop their pedagogical skills and strategies and increase their use of technology (Renninger & Shumar, 2004). In addition, compared with the one-time and face-to-face workshops, online programs can take various forms such as videoconferencing, electronic bulletin boards and web-based interaction combining text, video and sound. According to the report of a workshop done by the National Academy of Sciences (2007), online programs can be very convenient and tailored to meet teachers' different needs. By designing an online learning environment that fosters the development of a professional community, OTPD becomes more purposeful in meeting the personal ongoing professional development needs of teachers.

Along with its potential benefits, OTPD has certain challenges to its implementation and effective use. OTPD can be "richly interactive, in that it can give participants multiple opportunities to reflect on issues and questions (National Academy of Sciences, 2007, p. 4)." Nevertheless, obstacles to OTPD have been documented. First, although online courses offer teachers a way to read, reflect and discuss with other colleagues, OTPD requires that time be made available in teachers' schedules. Administrators sometimes assume that online professional development can be done on teachers' own time away from school, but this expectation is not fair (National Academy of Sciences, 2007). Typical school schedules do not really support OTPD. Therefore, a teacher has to be motivated to participate in OTPD. They should be given the same number of opportunities to participate in OTPD as face-to-face workshops. Otherwise, online tasks might be postponed to the end of teachers' priority list.

Second, for teachers who are not familiar with the Internet learning environments, OTPD is a challenge (Schlager & Fusco, 2004). Figuring out how to connect to Internet or using the online professional development model could be a problem for some teachers. When educators make their choices about online professional development, they rely heavily on peer opinions as well as scientific research (National Academy of Sciences, 2007). A lack of experience with OTPD therefore limits the likelihood of personal recommendations. Administrators are the ones who make decisions about professional development options and control the funding for them (National Academy of Sciences, 2007). Therefore, it is important that administrators know about the potential of online opportunities for professional development.

Regardless of these complexities, OTPD has been viewed as a potentially efficient way to deepen teachers' content knowledge and change their pedagogical practices, which could in turn improve student performance (Job-Sluder & Barab, 2004). Online teacher professional development fits well with today's fast changing K-12 educational environment that demands teachers continually to learn new content and pedagogy (Dede et al., 2006). These demands call for a more collaborative way of working. Online learning is a good way to support more collaboration among teachers (Park, Oliver, Johnson, Graham, & Oppong, 2007).

1.2. Synchronous discussion

From a sociocultural constructivist perspective of learning (Vygotsky, 1962), dialogic interactions between students and tutors are crucial for supporting negotiation of meaning that leads to knowledge construction. In online educational contexts, engagement between learning parties is largely facilitated by computer-mediated communication (CMC) technologies such as e-mail, chat rooms and discussion forums. According to the National Center for Accessible Media (2005), synchronous communication and collaboration tools, such as synchronous text chat, audio-conferencing, videoconferencing, and white boards, are increasingly important components of online learning. In educational settings, the synchronous CMC mode requires both facilitators and participants to be present at the same time for the dialogue to occur (Romiszowski & Mason, 2004).

A growing body of literature has explored the connectivity between technology and collaborative learning by using dialogue as a pedagogical tool to help students engage in online synchronous discussion for idea exchange (Duemer et al., 2002; Hsu, 2004; Shotsberger, 2000). Current research primarily focuses on evaluative case study results of videoconferencing (Locatis et al., 2003), university course (Dickey, 2003) and TPD program (Shotsberger, 2000). Research has shown that the synchronous text chat is useful for holding virtual office hours, team decision-making, and community building (Branon & Essex, 2001). Moreover, the quality of the synchronous discussion is appropriate for instructional activities that require interactivity, spontaneity and fast decision-making (Murphy & Collins, 1997). Burnett (2003) analyzed online chats in a distance education teacher training program due to the reason that online chat has been ignored as a means for productive group discussion between students and their tutors. Burnett's study demonstrated that "it is possible for tutors to address social, organizational, and intellectual aspects of discussion through online chat (p. 258)." In conclusion, synchronous communication tools allow multiple users not only to communicate using text messages, but also of enhancing student learning outcomes (Dickey, 2003).

On the other hand, the limitations of synchronous discussion include time constraint, lack of reflection time and difficulty in moderating larger scale conversations (Branon & Essex, 2001). Since online participants are not able to "see" other participants and so it is very likely that a person may interrupt someone else's reply (Herring, 1999). As a result, online users may find it difficult to focus on the dialogue. Thus, online participants need to develop new skills to manage multiple parallel threads of discourse created by other participants (Herring, 1999). It may be also important for the moderator to encourage students to take more responsibility for managing the focus of the discussion (Burnett, 2003; Duemer et al., 2002; Pilkington & Walker, 2003).

1.3. Analysis of online synchronous discussion

Content analysis of the qualitative data recorded in computer systems is a popular research methodology (Mowrer, 1996). Henri (1992) established a coding scheme to determine whether the content of CMC messages were social, interactive, cognitive, or metacognitive in nature. She identified five key dimensions for analysis of CMC discussion including (1) participation rate; (2) interaction types; (3) social cues; (4) cognitive skills and depth of processing which differentiates surface level processing from deep level processing; and (5) metacognitive skills and knowledge. Henri (1992) proposes that these five dimensions can be used to categorize electronic messages effectively.

Hara, Bonk, and Angeli (2000) used this coding scheme to analyze asynchronous discussions used in a graduate level course. They found that 70% of student postings reflected deep cognitive processing. Guan, Tsai, and Hwang (2006), using a coding scheme adapted from Henri's (1992) model, analyzed the synchronous discussion of several senior-high-school groups on a forum of virtual physics lab. These results seem promising for the value of synchronous discussions, though neither of these studies was conducted in an entirely OTPD course.

The function of online discussion in OPD is affected by many different factors. The factor "time sequence" plays an important role in terms of online discussion and has been utilized to analyze the peer interactions. Liu and Tsai (2008) found that issues and positions occurred mostly before the middle section of the discussion. The research result implies that knowledge exchange happened in early stage of the discussion. Similarly, in order to investigate the role of discussion conditions in an online forum, Guan et al. (2006) analyzed the message content in terms of the orders of the postings, which refer to the sequence of messages posted by a participant. The aim of their analysis was to find out whether the participants would make improvement in their use of cognitive and metacognitive skills and how the social cues and interaction patterns changed during the discussion. Their result indicated that the percentage of messages which was not related to the discussion topic increased because many participants were distracted from the main topic. In terms of cognitive skills, the percentage of non-cognitive messages noticeably increased in the second and up-third stage. Based on their research results, researchers should pay more attention to the issue of how to redirect participants' attention as the discussions progress. In light of the results from previous research, we examined the messages of different posting periods in order to understand how the messages may vary in terms of social cues, interaction, cognitive and metacognitive dimensions.

1.4. Participants' perceptions toward online discussions

While quantitative methodology was used for online content analyses in many research studies (Mowrer, 1996), there is a growing emphasis on qualitative tools such as interviews and observations (Anderson & Kanuka, 1997; Hara et al., 2000; Schrire, 2006). In Anderson and Kanuka's study of online forum of a teacher professional development program, they telephone interviewed nine participants. The interviews were designed to ask questions and probe issues from the survey results. From their interviews, all but one of the interviewees stated that the forum increased their knowledge to social access, which was one of the forum's goals. In addition, almost every respondent recognized the importance of the online forum, but only a few of them replied they really benefited from it. In a study on the social dimension of asynchronous learning networks (Wegerif, 1998), the researcher interviewed participants and found a number of them had been upset with the course, which was considered lack of structure. As Mason (1992) points out, survey techniques of CMC does not reflect group interactions. Therefore, she recommends the use of case study which does not limit the research to quantitative analyses of messages to frame the study in a holistic context (Schrire, 2006).

Based on the literature review, the research questions of this study were as follow:

1. What is the percentage/frequency of synchronous discussion in terms of social cues, interaction, cognitive, and metacognitive in OTPD?
2. How do messages vary by the time of posting periods in terms of social cues, interaction, cognitive, and metacognitive in the synchronous discussions of OTPD?
3. What are the participating teachers' perceptions towards the synchronous discussions of OTPD?

Our contribution to the study of OPD was to examine the role of a synchronous, text-based online conferencing environment in terms of interaction among moderators and participating teachers, and participating teachers' use of cognitive and metacognitive skills as they proceed in online discourses. In addition, the participants' perceptions towards synchronous discussion allow us to understand further the electronic discourse produced in synchronous computer conferencing of OPD. We believe our study can provide insightful information for teachers and educators who aim to design an OPD program having functions similar to the one in this study.

2. Method

2.1. Data sources

The participants in this study included 61 public school teachers who were enrolled in an OTPD course (Alternative Assessment for Mathematics Teaching) in the K-12 Digital School in Taiwan.[1] One moderator Mrs. Wu (pseudonym) was responsible for facilitating the course. It is a requirement that preservice teachers take a certain number of online professional development courses. Among 61 teachers, 19 of them were preservice teaches and 37 of them were inservice teachers. For the rest of five participants, we did not know their status. Among the inservice teachers, there were four junior high school teachers and 33 elementary school teachers (1–6th grade). In addition, 19 of them have taken courses in K-12 Digital School with Mrs. Wu. From their self introduction, most of them took the course because the positive experiences from their last course with Mrs. Wu.

2.2. Data collection

In order to make use of the benefits of both qualitative and quantitative method, the study utilized both methods to analyze the content of online discussion in the OTPD. Content analysis was chosen as the main methodology to analyze the online discussion because the present study is more concerned with analysis and categorization of text (Schwandt, 1997). Content analysis, a research technique for the objective and quantitative description of the content of communication, was able to fulfill the purpose of the study to examine the role of a synchronous, text-based online conferencing environment in terms of interaction among moderators and participating teachers,

[1] In an effort to promote web-based learning through teaching based on the 9-Year Compulsory Curriculum, the Ministry of Education in Taiwan made competitive plans to develop web-based professional development for teachers. One of those plans-Department of Education Excellence Plan-resulted in the K-12 Digital School (http://ds.k12.edu.tw/), an e-learning website providing teachers with professional development opportunities and helping teachers integrate technology into teaching activities.

and participating teachers' use of cognitive and metacognitive skills as they proceed in online discourses. In addition, we phone interviewed participating teachers as a supplement to quantitative data because interview enables the interviewer to probe or ask follow-up questions according to content analysis results. Phone interview was adopted because we have participants in widely distributed geographical areas. Moreover, phone interview is flexible to fit their busy schedules. By performing content analysis of the online discussions and interview, it was possible to arrive at a holistic understanding of the learning process.

The major data source in this study was the six online synchronous discussion transcripts containing a total of 3600 messages. Participating teachers attended 12 week-long, cross-district sessions which consisted of 43 h including 9 h face-to-face instruction, 6 h synchronous discussion (excluding the first and the last week), 16 h asynchronous discussion, and 12 h learning tasks. The course was designed to enhance teachers' knowledge and ability regarding alternative assessment and its application in mathematics instruction. The course also introduced "Polya's problem solving strategy[2]" to help their students solve mathematics problems. The teachers were required to participate in online synchronous discussions 1 h every Wednesday for six consecutive weeks. The synchronous discussion was held from 9:00 pm to 10:00 pm. Every week, one discussion topic was assigned by the moderators together based on course readings and materials. The synchronous discussion activities entailed teachers to discuss the topic of the week's readings. The six discussion topics were,

1. How to implement alternative assessment in mathematics class?
2. What do you think about the new curriculum standard?
3. How to use Polya's strategy in helping students solve mathematics problems?
4. How to improve students' computing skills?
5. Please share your experiences on implementing alternative assessment.
6. How to analyze the results from using the alternative assessment?

Another source of data was a semi-structured phone interview that focused on interactions happened during the online programs and teachers' perceptions with respect to the synchronous discussion of OTPD. The moderator and participating teachers were all interviewed. During the interviews, teachers were asked to reflect upon their experiences of synchronous discussion, evaluate its impact for OTPD, and to describe their ideal synchronous discussion and their suggestions for OTPD. The researchers also interviewed the moderator for 40 min in order to understand her perceptions of the functions and conceptions as well as her online moderating experiences of online synchronous discussions.

Participating teachers were first contacted by e-mail and those agreed to participate were interviewed on the phone for about 30 min. Ten teachers agreed to participate in the phone interview. Before conducting the phone interviews, the researchers contributed to the development of an interview protocol (see Appendix A). The interviews were semi-structured whereby interviewees were able to talk in their own words. In this way, issues we had not thought of sometimes were raised by our interviewees. Therefore, the researchers were able to adapt questions and conversations to specific contexts. For data triangulation purposes, the E-moderator, Mrs. Wu was also interviewed for 40 min. By collecting diverse sets of data, there was thought to be less chance of making errors or of drawing improper conclusions, than would be the case if relying upon just one data set (Arksey, 1999).

2.3. Data analysis

The framework for this study was that of Guan et al. (2006) which was modified from Henri's (1992) original model. Guan et al. (2006) simplified each dimension of Henri's model. For example, they did not distinguish "direct response" from "direct commentary." Instead, they only used the term "direct response" to represent both analytical categories. In this analysis framework, messages were categorized into four major dimensions: participation rate, social cues, interaction types, cognitive and metacognitive skills.

Participation rate is the number of messages posted by the moderator and participating teachers on average. Social cues refer to message which is not related to formal content of discussion topic but has certain social functions. Interaction types dimension is composed of four categories includes "direct response," "indirect response," "independent statement," and "other" (shown in Table 1). The categories of cognitive skills are "elementary clarification," "in-depth clarification," "inference," "judgment," and "strategies" (shown in Table 2), whereas the metacognitive skills involve "evaluation," "planning," "regulation," "self-awareness," and "none" (shown in Table 2). Tables 1 and 2 also show the information on definitions, indicators, and examples of each category. What should be noticed here is that cognitive and metacognitive skills are mutually exclusive. Each message was coded only once in this dimension. For example, "The purpose of alternative assessment is meaningful, but how should we put it into practice?" was categorized as "cognitive skills" ("judgment" in Table 2). An example of metacognitive skill message will be "I agree with Sandy. I think we should now design a detailed plan and do it this way!" ("planning" in Table 2). As mentioned previously, participation rate was the total number of messages divided by the number of moderator and participating teachers on average. The data indicate the frequency of participating teachers and moderator participation. Therefore, the coding of online messages only involves three other dimensions (social cues, interaction types, cognitive and metacognitive skills).

The coding of online synchronous discussion messages was performed by two coders. The coders coded every message based on the analytical framework modified from that by Henri (1992) (i.e. social cues, interaction types, cognitive and metacognitive skills). Each message was analyzed first dimension by dimension (e.g. interaction types) and then categorized into one specific category (e.g. direct response, indirect response, independent statement, other). In other words, each message was coded three times for three dimensions (social cues, interaction types as well as cognitive and metacognitive skills). Two coders first engaged in the coding processes independently. They then discussed their results with each other. The complete set of data (3600 online synchronous discussion messages) was analyzed by both coders. When the coders did not agree on the coding, the following process was used to reach consensus on how to code the messages. First, each coder stated their reasons based on the framework. When the two coders felt it was not clear what category a message should go, they would go over the messages again and make modifications to resolve the ambiguities.

[2] Polya's problem solving strategy contains four steps to problem solving: (1) understanding the problem; (2) devising a plan; (3) carrying out the plan; (4) looking back.

Table 1
The analytical model for participation rate, social cues and interaction types.

Dimension	Category and/or definition	Indicators
Participation rate	Number of messages posted by one person on average	Number of messages on average
Social cues	Statement which is not related to formal content of subject matter	• Self-introduction • Verbal or symbolic expression of feelings • Jokes • Greetings
Interaction types	*Direct response*: Any statement directly responding to the thread, a question, or a commentary that is related to the subject under discussion, using a direct reference	• Messages respond to the discussion thread • Messages replied to a certain message • Messages that mention names
	Indirect response: Any statement responding to the thread, a question, or a commentary that is related to the subject under discussion, without providing a reference	• Messages respond to the discussion thread indirectly • Messages that do not provide any reference
	Independent Statement: Any statement relating to the subject matter under discussion, but which is neither an answer nor a commentary and does not lead to any further statements	• Messages that are not responded by other participants • Messages that do not respond to previous statements
	Other: Any statement that is not related to the subject under discussion	

Table 2
The analytical model for cognitive and metacognitive skills.

Cognitive skills	*Elementary clarification*: Observing or studying a problem identifying its elements, and observing their linkages in order to come to a basic understanding	• Identifying relevant elements • Reformulating the problem • Asking a relevant question • Identifying previously stated hypotheses • Request clarification
	In-depth clarification: Analyzing and understanding a problem to come to an understanding which sheds light on values, beliefs, and assumptions which underlie the statement of the problem	• Defining the terms • Identifying assumptions • Establishing referential criteria • Seeking out specialized information • Revising or refining statements
	Inference: Induction and deduction, admitting or proposing an idea on the basis of its link with propositions already admitted as true	• Drawing conclusions • Making generalizations • Formulating a proposition which proceeds from previous statements
	Judgment: Making decisions, statements, appreciations, evaluations, and criticisms	• Judging the relevance of solutions • Making value judgments • Judging inferences
	Sizing up *Strategies*: Proposing coordinated actions for the application of a solution, or for following through on a choice or a decision	• Deciding on the action to be taken • Proposing one or more solutions • Interacting with those concerned
Metacognitive skills	*Evaluation*: Assessment, appraisal or verification of one's knowledge and skills, and of the efficacy of a chosen strategy	• Asking whether one's statement is true • Commenting on one's manner of accomplishing a task • Raising doubts and querying
	Planning: Selecting, predicting and ordering an action or strategy necessary to the accomplishment of an action	• Predicting the consequences of an action • Organizing aims by breaking them down into sub-objectives
	Regulation: Setting up, maintenance and supervision of the overall cognitive task	• Redirecting one's efforts • Recalling one's objectives • Setting up strategies
	Self-awareness: Ability to identify, decipher and interpret correctly the feelings and thoughts connected with a given aspect of the task	• Expression of feelings connected with one's accomplishment • Being aware of one's own cognitive strategies
	None: No cognitive or metacognitive compliment is found in the message	• Any statement that is not related to the subject under discussion

Interview data in the study were analyzed qualitatively using constant comparative method (Glaser & Strauss, 1967) through open coding (Strauss & Corbin, 1990). Without using an existing system of categories or codes, the data analysis in this study focused on patterns and categories emerged from the data. Coding the interview data was the first step of data analysis. We organized categories and subcategories in terms of their properties by comparison and contrast after they were identified (Strauss & Corbin, 1990). This meant adding and modifying codes on the basis of prior coding and eliminating codes to reflect the developing theoretical framework. Significant elements were organized into a new data-driven context that was then developed into a description regarding how participating teachers perceived synchronous online discussion for OTPD (Muldur, 1994).

In the beginning of analysis, the data was coded with a large amount of codes. Researchers then found and explored similarities among the codes. For example, it became obvious that two kinds of activities appeared most frequently in defining the functions of the weekly synchronous discussions. Several participating teachers mentioned that synchronous online forum allows them to communicate from multiple perspectives. One of the participating teachers commented that the discussion can offer teachers a common language to communicate with each other about teaching and learning. They spent a lot of time sharing experiences including teaching experiences and online learning experiences during the discussions. Therefore, sharing teaching experiences and sharing online learning experiences were subsumed under the code of sharing experience. Afterwards, sharing experience, social interaction, information exchange and intellectual development were then categorized into the functions of synchronous online discussions. Additional coding and recoding of the data confirmed this category as an important construct for understanding participating teachers' perceptions for synchronous discussions. In the end,

two categories were identified as particularly important: orientations and functions entailed by the OTPD (see Appendix A for the list of derived codes and examples.). There were four codes under the category of orientation of synchronous discussions: moderator-centered, participant-centered, participant–moderator interaction, and moderator as a regulator. For the category of functions, sharing experiences, social interaction, information exchange and intellectual development were included. The researchers were able to make descriptions about the synchronous discussion of OTPD in the results section with the derived categories and codes. This analysis was carried out in conjunction with reviewing relevant literature to confirm decisions made in the coding process. For example, the code "information exchange" led to literature that most of the conversation in synchronous discussion was of a sharing nature (Garrison, Anderson, & Archer, 2000). Validation was provided by triangulation involving multiple researchers to combine different views for interpretation of the data (Denzin, 1995).

3. Results

In this section, the results are presented in two major parts. The first part consists of findings from the analysis of online messages by the participating teachers and the second part shows the interview results and how teachers conceptualize OTPD.

3.1. Analyses of online messages

3.1.1. The overall analysis of messages

A total of 3600 synchronous discussion messages from six discussions were posted by 63 participating teachers. As for the moderator, Mrs. Wu posted 280 messages throughout the six discussions, which is about 3.4% of the total messages. The participation rate (number of message on average per participant) was 57.1. Table 3 demonstrates the quantitative data on participation of the six synchronous discussions. Participation across the 6 weeks of conferencing was quite consistent. According to the data, most of the messages were posted by the participating teachers, not the moderator, indicating that teachers dominated the discussion. Most messages posted by the moderator were surface statements. When discussing Polya's strategy, the moderator posted the following messages. For example, "The first step of Polya's strategy is to understand the meaning of the question. Do you think this is what you do in class?" and "How to help students understand the meaning of the question?" The moderator repeated the second question three times. In addition to basic clarification messages, part of the moderator's messages was feedback to participating teachers. For example, "You did a good job involving students in the reasoning process!" or "Sandy, when teaching young children, you may try to explain the question part by part to help students understand the meaning of the question." The moderator tried to create an open learning atmosphere that helps teachers take charge of the conversation and respond to each other.

Among all messages, 27% of the messages were related to social cues dimension (see Table 4). Table 4 shows the percentage of social cues messages for the 6 weeks. The percentage of social messages decreased as the semester progressed and suddenly increased in the last discussion. 66.9% of the messages in the last discussion were for social purposes. With regards to interaction types, there were more "indirect response" messages than "direct response" messages. Table 5 shows that the most frequently involved category of interaction type among the six discussions was "other" (44.6%, 51.6%, 46.1%, 36.2%, 69.3% and 68.4% from the first to the last discussion), followed by "indirect response" (42.9%, 39.5%, 40.1%, 41.1%, 25.8% and 27.1% from the first to the last discussion). Throughout the six discussions, 52.1% of the messages were not relevant to the discussion topics. There were very few "independent statement" messages, which was only 0.2% in total.

Regarding the metacognitive skills, it was quite consistent from week-to-week that only a few messages revealed metacognitive skills (2%, 0.8%, 6.2%, 5.2%, 2% and 0.4% from week 1 to week 6, shown in Table 6). Only 27.7% of the messages showed that participants used their cognitive and metacognitive skills when engaging in synchronous discussion. Messages were not incorporated any cognitive and metacognitive skills were categorized as "none" (67.1%, 86%, 54.6%, 63.3%, 86.8% and 77.9% from the first to the last discussion in Table 6). Broken down by different categories, "elementary clarification" was the most often used cognitive skill (401 messages, 11.1%), followed by "inference" (140 messages, 3.9%) and "strategies" (135 messages, 3.8%). The number of metacognitive messages is far less than that of cognitive messages. The most frequent used skill was "evaluation" (46 messages, 1.3%).

Table 3
Participation rate across different weeks.

Week	Total # of messages	Total # of moderator's messages	Total # of teachers' messages	Participation rate
Week 1	617	53	564	9.8
Week 2	631	34	597	10.0
Week 3	624	64	560	9.9
Week 4	629	47	582	10.0
Week 5	616	34	582	9.8
Week 6	483	48	435	7.7
Total	3600	280	3320	57.1

Table 4
Messages of social cues from the six online discussions.

	Total # of social cues messages	Total # of messages	Percentage (%)
Week 1	186	617	30.1
Week 2	131	631	20.8
Week 3	108	624	17.3
Week 4	104	629	16.5
Week 5	120	616	19.5
Week 6	323	483	66.9
Total	972	3600	27

Table 5
Interaction types of the online messages from the six discussions.

	Direct response	Indirect response	Independent statement	Other
Week 1	77 (12.5%)	265 (42.9%)	0	275 (44.6%)
Week 2	54 (8.6%)	249 (39.5%)	2 (0.3%)	326 (51.6%)
Week 3	84 (13.5%)	250 (40.1%)	2 (0.3%)	288 (46.1%)
Week 4	140 (22.4%)	257 (41.1%)	2 (0.3%)	230 (36.2%)
Week 5	30 (4.9%)	159 (25.8%)	0	427 (69.3%)
Week 6	22 (4.5%)	131 (27.1%)	0	330 (68.4%)
Total	407 (11.3%)	1311 (36.4%)	6 (0.2%)	1876 (52.1%)

Table 6
Cognitive and metacognitive messages from the six discussions. 认知技能 元认知技能

	EC	IC	INF	JUG	STR	EVA	PLAN	REG	SELF	None
Week 1	95 (15.3%)	10 (1.6%)	30 (4.9%)	26 (4.2%)	30 (4.9%)	5 (0.8%)	6 (0.9%)	2 (0.3%)	0	416 (67.1%)
Week 2	30 (4.8%)	16 (2.5%)	12 (1.9%)	15 (2.4%)	10 (1.6%)	5 (0.8%)	0	0	0	542 (86%)
Week 3	73 (11.7%)	27 (4.3%)	53 (8.5%)	38 (6.1%)	53 (8.5%)	17 (2.7%)	14 (2.2%)	2 (0.3%)	6 (1.0%)	341 (54.6%)
Week 4	81 (12.9%)	20 (3.2%)	37 (5.9%)	38 (6.0%)	22 (3.5%)	15 (2.4%)	12 (1.9%)	0	6 (0.9%)	397 (63.3%)
Week 5	36 (5.8%)	11 (1.8%)	6 (1.0%)	5 (0.8%)	11 (1.8%)	4 (0.6%)	5 (0.8%)	0	4 (0.6%)	533 (86.8%)
Week 6	86 (17.8%)	2 (0.4%)	2 (0.4%)	6 (1.2%)	9 (1.9%)	0	0	2 (0.4%)	0	376 (77.9%)
Total	401 (11.1%)	86 (2.4%)	140 (3.9%)	128 (3.6%)	135 (3.8%)	46 (1.3%)	37 (1.0%)	6 (0.2%)	16 (0.4%)	2605 (72.3%)

EC: elementary clarification; IC: in-depth clarification; INF: inference; JUG: judgment; STR: strategy; EVA: evaluation; PLAN: planning; REG: regulation; SELF: self-awareness.

3.1.2. The analysis of message by the time of postings

In order to find out whether the participating teachers would involve in different interaction types and skills concerning cognitive and metacognitive dimensions in different time condition, we examined the content of each message by the time of postings. Messages were divided into three groups from the beginning to 20 min, 20–40 min and 40 min to the end of the discussion. In Table 7, results on the analysis of the first, second and third posting periods were displayed.

The results indicated that the percentage of social dimension was significantly different among the first, second and third posting periods (shown in Table 7). In the first posting period and the third posting period, participants posted more messages for social purpose than in the second posting period. 32.8% of the messages in the first posting period and 26.3% of the messages in the third posting period were related to social cues dimension comparing to 16.3% of the messages in the second posting period. Significant differences were also found in "interaction types" and "cognitive and metacognitive skills." 15.46% of "direct response" messages were found in the second posting period but the number of message decreased in the last posting period. For indirect response, the third posting period also had less messages comparing to the first or the second posting period. As the discussion came to an end, more and more messages (73.56%) were not related to the discussion topic.

Table 7
The percentage of each coding category based on the time of online postings.

Postings	Social cues (%)[a]	Interaction types(%)[b]				Cognitive and metacognitive (%)[c]									
		DR	IR	IS	Other	EC	IC	INF	JUG	STR	EVA	PLAN	REG	SELF	None
Beginning-20 min	32.8	11.6	48.36	0.4	39.64	15.28	4.8	4.59	3.88	5.08	1.96	1.04	0.16	0.81	62.4
20–40 min	16.3	15.46	40.64	0.31	43.59	10.56	3.26	6.60	4.43	4.43	1.24	1.01	0.23	0.78	67.46
40 min-end	26.3	7.77	18.59	0.08	73.56	6.13	0.60	0.47	1.54	1.13	0.73	0.73	0.13	0.13	88.41

SO: social cues; DR: direct response; IR: indirect response; IS: independent statement; EC: elementary clarification; IC: in-depth clarification; INF: inference; JUG: judgment; STR: strategy; EVA: evaluation; PLAN: planning; REG: regulation; SELF: self-awareness.

[a] $\chi^2(2) = 106.167$, $p < 0.001$.
[b] $\chi^2(6) = 99.78$, $p < 0.001$.
[c] $\chi^2(18) = 298.519$, $p < 0.001$.

With regard to cognitive and metacognitive skills, over half of the messages were not involved with any cognitive and metacognitive skills (62.40% for the first posting period, 67.46% for the second posting period and 88.41% for the third posting period. The third posting period had fewer cognitive and metacognitive messages (11.59%) than the first (37.6%) or the second (32.54%) posting periods throughout six discussions. The most frequently used cognitive skill was "elementary clarification" and "evaluation" was the most frequently used metacognitive skills. In general, there were very few messages that displayed any cognitive skills. There were even fewer messages involved metacognitive skills throughout the first (3.97%), second (3.26%) and third (1.72%) posting periods.

3.2. Interview results-conceptions and perceptions of synchronous discussion for OTPD

Analysis of the transcripts of interviews with 10 teachers shows clear evidence of the perceptions of synchronous discussion for the OTPD program. We asked the teachers to describe their ideal synchronous discussion for OTPD activities and then their perceptions towards their synchronous discussion experiences in this OTPD program. We also encouraged teachers to talk about the strengths and weaknesses of the discussions that they have participated in. The results are summarized in Table 8.

3.2.1. Conceptions of synchronous discussion

When asked the first question (i.e. What is your ideal synchronous discussion?), the 10 teachers we interviewed can be categorized as "moderator-centered," "participant-centered," "moderator as regulator" and "participant–moderator interaction" (Table 8). For example, Jean was identified as having the orientation of moderator-centered. She described her ideal synchronous discussion for OTPD as "moderator-centered ... the moderator should lead the discussion." The moderator should act as an educational facilitator and use questions for student responses that focus discussions on critical concepts to enhance professional knowledge. OTPD has to change the knowledge and beliefs of teachers in order to be effective (National Academy of Sciences, 2007). According to Jean (pseudonym), she suggests that changing teachers' beliefs and values in an OTPD course often requires the moderator to set the standards and constantly help the participants probe the questions. Jean says,

> Using online technologies to learn new teaching practices can be difficult. It is hard to watch other teachers' practice and then transfer it into my own context. It is a lot more complicated than that. Therefore, the moderator plays a critical role in helping participants reflect and change their practice.

This suggests that the OTPD moderator should use questions and probes for participating teachers' responses that focus discussions on critical concepts, principles and skills.

For Rebecca (pseudonym), the moderator plays a role of regulator. "Instead of leading the discussion, he or she is responsible for keeping participants focusing on the topic." Because participants can feel estranged in an OTPD course, providing timely evaluations of work is critical. On the other hand, Henry's ideal learning environment is "participant-centered." Henry (pseudonym) says, "Participants, instead of the moderator should lead the discussion." According to Henry, the moderator should create a friendly, social environment in which learning is promoted. Henry's conception of synchronous discussion fits well with Joan's views towards synchronous discussion in terms of online teacher professional development. Joan thinks that OTPD programs can help build the community that is often missing from teachers' daily lives. She also agrees that OTPD can offer teachers a common language to communicate with each other about teaching and learning. For Joan (pseudonym), developing group cohesiveness and helping participants to work together are all critical to success of OTPD programs.

In addition, five teachers considered online synchronous discussion as "participant–moderator interaction." For Tom, Marie, Andrew, Bill and Katherine (all pseudonyms), the meaning of synchronous discussion is constructed by both participants and moderators. For example, Bill prefers more interaction among participants and the moderator. Bill says, "The moderator must make participants comfortable with the system that the group is using." For Bill (pseudonym), successful OTPD courses need a space for communication. Moderators and participants who engage in the discussion would learn from each other. Not only participants but also moderators benefit from getting involved in the synchronous discussion.

3.2.2. Perceptions towards synchronous discussion

Table 8 also demonstrates the perceptions of the 10 participating teachers that we interviewed for synchronous discussion. Henry is a new user of the OTPD program. When being asked about the function of synchronous discussion, he describes his perception of synchronous discussion as being to "share teaching experiences ... but that's all" Henry said. According to Henry, theory-oriented discussions "scare away" teachers who participate in the synchronous discussion. On the other hand, Andrew is an experienced user of the K-12 digital school system and has technology expertise. Andrew thinks that although it is difficult to stop everyone from chatting, synchronous discussion does provide participating teachers a way to exchange information. He also mentions that synchronous discussion is the essence of OTPD. This is what differentiates OTPD from traditional face-to-face professional development. His opinions are consistent with Joan, who

Table 8
The online teacher professional development experiences of 10 participants.

Participant	Orientation to synchronous discussion	Functions of synchronous discussion
Jean	Moderator-centered	Sharing experiences
Henry	Participant-centered	Social and sharing experiences
Tom	Participant–moderator interaction	Social
Joan	Participant-centered	Sharing experiences
Marie	Participant–moderator interaction	Information exchange
Rebecca	Moderator as a regulator	Intellectual development and social
Eddie	Participant-centered	Intellectual development and social
Andrew	Participant–moderator interaction	Sharing experiences and information exchange
Bill	Participant–moderator interaction	Sharing experiences
Katherine	Participant–moderator interaction	Sharing experiences

is an enthusiast for the use of synchronous discussion for OTPD. "Online communications can establish connections among participating teachers. With OTPD, you can share teaching practices with teachers from outside of your school." Joan says.

There are some factors affecting participating teachers' views of synchronous discussion for OTPD. One of these factors was technical computing expertise. Take Andrew for example, his technical expertise may contribute him to make good use of online materials and view synchronous discussion positively. In addition, convenience and resource efficiency also appear to be important motives. Teachers who have access to computer and internet tend to have better online learning experience. For example, 2 out of 10 teachers (Bill and Joan) who have easy access to Internet think positively about online learning. Bill says, "OTPD can save my time in searching teaching materials, giving each other feedback and providing subject information."

Eight among the 10 interviewed teachers believe that synchronous discussion had changed the way they learn. Several teachers emphasize the convenience of synchronous discussion. As Joan comments,

> I came in contact with ideas that I never would have come in contact before. It would take me a lot longer to learn it on my own.

Rebecca also says, "The value of online synchronous discussion may simply allow us to interact with each other and to brainstorm." The group of teachers uses synchronous discussions to post their opinions and ideas for feedback from the others. Bill explains the value of the group for sharing others' perspectives, exchanging ideas, and developing their thoughts. He says, "I think the advantage of the synchronous discussion is to share your opinions and get feedback from others immediately. I can push my understanding beyond my own limits by considering the ideas of others in the group." Therefore, the interview data shows that there is some tentative evidence that the participating teachers view synchronous discussion as an avenue to request and provide information as well as to share their teaching ideas.

When interviewed, two teachers (Katherine and Rebecca) agree that they would seek group solutions for problems they encountered in teaching. Katherine says,

> I feel comfortable to ask questions and make comments online. I tend not to ask questions in physical workshop because sometimes I worry if this could be a stupid question.

Theses teachers feel comfortable to ask questions online as compared to face-to-face group interaction where learning could be influenced by social status, beliefs and values.

However, some teachers do not believe that synchronous discussion can foster their learning. As Marie comments,

> Online chat can quickly become into non-productive chaos. I think we need to self-monitor our roles in the discussion rather than being monitored by the moderator.

Similarly, Andrew says, "synchronous techniques are not as effective as regular classroom discussion for OTPD ... my experience suggests that eliminating synchronous discussion may not be a great loss."

Based on the interview data, synchronous discussions appear to hold little advantage compared to face-to-face discussions for several participating teachers that we interviewed. The problem may be resulted from lack of self-regulated skills for the participants.

4. Discussion

Based on our data, we found that the discussions were dominated by the participating teachers. The moderator gave questions each week for the participating teachers to follow. During the 6 weeks synchronous discussions, the moderator only posted 280 messages. According to our interview with the facilitator, she considered online forums as a vehicle to support professional development, not to lecture. In order to achieve the purpose, the moderator tried to increase participating teachers' knowledge through the rich resources of practical knowledge acquired by other professionals. Another feature of the discussion was that social messages appeared mostly in the first and the third posting periods. Twenty-seven percent of the messages were categorized as social cues throughout the six discussions. Especially in the initial 20 min and the last 20 min, participating teachers posted more social messages. In the last week of discussion, 66.9% of the messages were categorized as "social cues." Therefore, we suggest that the function of the synchronous discussion for OTPD was mainly for relation building purpose for participating teachers.

Additionally, although the moderator tried to guide the discussion by giving questions, the participating teachers did not just focus on the course materials. In this study, 52.1% of the messages were categorized into "other" under the "interaction types" dimension. This suggests that over half of the messages were not related to the discussion topics. Previous research (Curtis & Lawson, 2001) has distinguished between types of conversational contributions which are "on-topic," about the concepts to be learned, and those which are "off-topic." Similarly, Stacey (1999) analyzed three groups comprised of 31 part-time graduate MBA students and found that groups spent their time on what could be considered both on-topic (clarifying ideas; obtaining feedback; sharing perspectives, seeking solutions) and off-topic (providing emotional and technical support conveying commitment to the group; changing ideas as needed and managing group activities). Paulus (2009) analyzed small group interactions in an online graduate level educational psychology course. In Paulus's study, during 2-week course, the 21 students posted a total of 2552 messages. Sixty-one percent of theses messages were off-topic. However, these "off-topic" elements of the discussions are likely to serve a meaningful purpose for the participants. For example, Garrison et al. (2000) suggests a critical inquiry framework for analyzing synchronous discussions. Their framework includes indicators of social presence, cognitive presence and teaching presence. The social presence dimension consists of emotional expression, open communication and group cohesion. Thus, part of the off-topic messages in CMC environments is to establish presence in the absence of physical existence (Paulus, 2009). In this study, the off-topic messages in the CMC environments were to share their teaching ideas, provide useful information and support each other. Participating teachers engaged in conversations as they worked together on assigned tasks as well as shared their ideas and reflected their teaching. The data suggest that social messages in OTPD programs are necessary to sustain instructional interaction over the entire discussion. For OTPD, social messages are likely necessary to create and foster a community of talk.

In terms of the interaction types, we found that participating teachers posted more indirect messages than direct messages. According to the interview data and message content, most teachers did not know each other before taking the course. Our findings show that most messages indirectly responded to the discussion thread regardless of the order of postings. For example, someone might respond to one

point while the next person might respond with a totally unrelated statement. In a face-to-face setting, when the conversation starts, a moderator can intervene right away and get things back on track. But in the online settings, irrelevant or distracting messages stay as part of the discussion. Indeed, it requires a sensitive moderator who uses tactful strategies to facilitate information sharing, knowledge construction, and achieving other learning goals (Collison, Elbaum, Haavind, & Tinker, 2000). In an OTPD program, a moderator needs to be aware of the decision they make and the consequences it might have for participating teachers' learning. Interaction types might also have an important impact on participating teachers' cognitive engagement due to the goals that a moderator sets for synchronous discussions.

In this study, the percentage of cognitive and metacognitive messages was fairly low. This result resembles findings from the previous research (Garrison et al., 2000), which found that most of the conversation in synchronous discussion was of a sharing nature. It might be resulted from the guidance of the moderator. The moderator assigned a topic for each synchronous discussion. Theses topics were not theoretical-oriented and tended to invite participating teachers to share their experiences on the use of the alternative assessment taught by this online program or their perceptions. According to the data, the moderator asked questions to facilitate the discussion. Most of the questions were categorized as elementary clarification question and judgment question. However, when the moderator asked questions which contained sentences that required the application of cognitive skills, participating teachers tended to exhibit more cognitive skills. Given above results, it seemed that the moderator's questions provide considerable direction to the types of cognitive skills exhibited in online discussion. As the moderator said "When moderators were actively involved-responding regularly, posting new messages, encouraging activities and discussions, students responded with enthusiasm and regular participation." However, due to the number of students and messages, the moderator could not respond to each comment at the same time. Nevertheless, students who responded to the moderator's questions of their interest usually had more probability of reaching higher-order cognitive skills. The moderator was positive about participating teachers' reaction. She thought it was plausible that participating teachers enjoyed their opportunities for written expression without the anxiety provoking negative comments they may have experienced before.

Our interview data revealed that OTPD in this study was a place where teachers came together to share values and knowledge as well as make connections for the purpose of mutual benefit professional development. Teachers with better computer skills might have better chance to master professional development programs online. Although most teachers we interviewed viewed online synchronous discussions positively, some teachers did not think online synchronous discussion was effective. The action of social sharing and knowledge construction did not happen online naturally. Instead, knowledge construction happens because of the careful planning of learning activities and facilitation during the learning process. If synchronous discussion cannot engage participants in higher level of cognitive thinking, they may not learn from the discussion. Therefore, the moderators might involve participating teachers in the discussion and help them think critically by using synchronous discussions for controversial topics, e.g., new theory or ideas. The moderator can also post messages containing disagreements to elicit more responses from participating teachers in an OTPD course.

Based on our interview data, lack of self-regulated skills is another issue for participating teachers. Self-regulated learners are both active and reflective participants and assume greater control and responsibility in the learning process (Garrison & Cleveland-Innes, 2005). Garcia and Pintrich (1994) state that self-regulation refers "to students' monitoring, controlling, and regulating their own cognitive activities and actual behavior (p. 143)." The nature of online learning calls on learners to be self-monitored and to be responsible for their learning. That is, to assume greater control of monitoring and managing the cognitive aspect of their learning (Garrison & Cleveland-Innes, 2005). For moderators, this is a challenge because they have the responsibility to provide guidance that will support students assuming increased control of their learning. If the participants could recognize the properties of synchronous online learning that encourages reflection and provides opportunities for teamwork and dialogue, there is a reason to believe that synchronous discussion can be effective in supporting higher-order thinking and creating valuable cognitive presence online (Zhu, 2006). For OTPD, it is unrealistic to expect that learning happen naturally without facilitation. Moderators should understand characteristics of synchronous discussion for OTPD and utilize discussion design and questions to improve participating teachers' learning outcomes.

5. Conclusions and implications

The purpose of the study was to explore the nature of interaction of OTPD and the perceptions of participating teachers toward it. This study details ways to use Henri's model for analyzing electronic discussions. Analyses revealed that electronic conferencing about OTPD results in an environment for teachers to facilitate interaction and develop a sense of learning communities. Based on our findings, we suggest the following conclusion.

First, participating teachers tended to learn from each other and have more time to make social contributions that would be possible in a traditional face-to-face professional development course. According to the data, 27% of the messages were related to social cues dimension, 52.1% of the messages were categorized into "other" under the "interaction type" dimension. This result also showed that although teaching has been viewed as an isolated work because many factors restricted teachers' collaboration (Park et al., 2007), when teachers meet online, they would be able to reflect on their practices through discussions with colleagues from different areas. In this regard, online professional development provides an environment for teachers to facilitate interaction and develop a sense of learning communities as face-to face mode.

Second, attention must be given to the opportunity to reflect upon and monitor knowledge construction as well as the ability to manage the learning process for online learning participants according to our interview results. There was a pattern noted within the discussion by the time of postings. The third posting period had fewer cognitive and metacognitive messages than the first and second posting periods. Overall, only 27.7% of the total messages showed that the participants used their cognitive and metacognitive skills. Most of these messages were at the surface level in terms of information processing. Learning happens in a socially situated educational context, which demonstrates the importance of interaction and community to reveal cognitive and metacognitive knowledge and skills. It could be argued that synchronous discussion has a unique advantage over face-to-face learning in creating a cognitive environment and achieving meaningful learning outcomes (Zhu, 2006). For OTPD, online self-regulatory support should be offered. For example, adaptive scaffolding (i.e. a moderator who continuously diagnoses participants' understanding) (Azevedo, Cromley, & Seibert, 2004) might be considered in supporting participating teachers' self-regulatory processes and learning performance. For online synchronous to be effective, participants should try to monitor and regulate one's knowledge and learning processes.

Third, online moderation is a skill that should be learned by prospective moderators. The impact of synchronous discussion relies on the course design, quality of discussion and discussion topic. Based on our data, participating teachers posted a large amount of social messages in the beginning and the end of the discussion (see Table 7). Besides, Table 7 shows that as the discussion moved toward the end, most messages (73.56%) were unrelated to the discussion topic. This result indicated that in order to facilitate the discussion and help teachers focus on the topic, the moderator needs to pay attention to redirect teachers to assigned discussion topic and engage them in deep learning. A major challenge facing the moderator in web-based learning settings is how to structure synchronous discussions in order to engage participants in meaningful discourse. Our findings also revealed that most of the moderator's messages did not involve any cognitive and metacognitive skills. For moderators, besides guiding participants as they learn through their dialog with each other, they can also lead the group to create, maintain, and evaluate the communication culture within the course. Therefore, how to provide a comfortable environment so that the participants are willing to share, and also push them to focus on the discussion topic and to reflect their own knowledge and improve their practice will be the main challenge for moderators involved in OTPD.

Last, web-based learning has the potential to expand and enrich learning opportunities for educators by employing alternative processes not available in face-to-face instruction. However, the infusion of technology cannot act as a panacea for TPD (Gess-Newsome, Blocher, Clark, Menasco, & Willis, 2003). Rather, the way we use this technological tool is important in order to make OTPD more effective. Planning for integration of synchronous online interaction tools in online courses is one of the most prominent variable influencing teachers' learning. This study demonstrated how participating teachers involved in the synchronous discussion and how they felt about synchronous discussion for OTPD. The interview results revealed several deficiencies in the synchronous discussion for OTPD that might discourage potential users from participation. As noted in the interview results section, some participants felt that the information exchange during the synchronous discussion was not effective. Based on these data, it needs to be determined if effective moderation can facilitate the online discourse of online communication to be more interactive. The facilitators of OTPD activities have a responsibility not only to provide information but also to provide opportunities for participants to use their cognitive and metacognitive skills, and to assist them in developing new knowledge. This way, OTPD programs will provide an opportunity for participating teachers to improve the way they increase their body of knowledge through a critical and analytical process of acquiring and practicing new knowledge.

Further research is needed to explore whether other factors might have an impact on the synchronous discussion for effective OTPD. For example, the familiarity with synchronous discussion, access to synchronous discussion, prior knowledge and the topic of the discussion might influence teachers' learning. The focus of this study was online synchronous text-based discussion. Another study on online synchronous video-based discussion should also be taken into account. Information about participating teachers' demographic information and their background information should be collected for further analyses. It would be interesting to study more closely on specific learners who have participated OTPD courses for quite a long time and analyze their online synchronous discussion behaviors as well as experiences.

Acknowledgments

Funding of this research work is supported by National Science Council, Taiwan, by Grant numbers 94-2511-S-009-003, 95-2511-S-011-002 and 96-2511-S-011-001.

Appendix A

A.1. Interview protocol

1. What is your ideal synchronous discussion?
2. What is your perception toward the synchronous discussion that you have participated?
3. How would you describe synchronous discussion for web-based teacher professional development?
4. What kind of messages did you post during the synchronous discussions? What about your colleagues?
5. What changes can you identify in your own experience?
6. Did you notice any kind of interaction in synchronous discussion?

A.2. Derived codes

Categories	Codes	Examples
Orientations of the OTPD	Moderator-centered	The moderator should lead the discussion
	Participant-centered	The moderator should create a friendly environment in which learning is promoted
	Participant–moderator interaction	I prefer more interaction among participants and the moderator. Successful OTPD courses need a space for communication
	Moderator as a regulator	In stead of leading the discussion, the moderator is responsible for keeping participants focusing on the topic
Functions of the OTPD	Sharing experiences	The OTPD offers teacher a common language to communicate with each other about teaching and learning
	Social interaction	Online communications can establish connections among teachers outside of your school
	Information exchange	Although it is difficult to stop everyone form chatting, synchronous discussion does provide participating teachers a way to exchange information
	Intellectual development	I came in contact with ideas that I never would come in contact before. It would take me a lot longer to learn it on my own

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