Pre-service teachers' perceptions of an online mathematical problem solving course: A constructivist approach

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This study was conducted to investigate the effectiveness of teaching a mathematical problem solving course via the Web using a social constructivist approach. This study looked at participants' perceptions and satisfactions with the online learning environment. A total of 37 pre-service teacher trainees at the Batu Lintang Teacher Institute, Sarawak, Malaysia were the participants of this study. In this online course, the participants were required to complete the course online without face-to-face classes and they were also required to solve authentic mathematical problems in small group of 4-5 participants based on the Polya's Problem Solving Model via online asynchronous discussion. The online asynchronous discussion enabled the participants to discuss and share knowledge and solutions. Quantitative and qualitative methods such as questionnaires and interviews were used to evaluate the effects of the online learning. Findings in this study showed that majority of the participants were satisfied with their learning experiences in the course. The participants also perceived that they need to have positive attitudes, self discipline, self-independence, and self confidence to succeed in the course. Some of the difficulties faced by the participants in the course were technical problems, inadequate computer training for some of the required software and feeling of isolation. Thus, the online mathematical problem solving course using the social constructivist approach was appropriate and ought to be given serious attention as an alternative to traditional classes. Nonetheless, pedagogical considerations should be taken into account in designing and implementing online courses to minimise problems that participants might encounter while participating in such courses.

Keywords: online course, social constructivist, mathematical problem solving, satisfactions

Introduction

According to Gallagher (2001), the Web is an effective tool for teaching and learning and indeed the Web is increasingly being used as a teaching and learning tool throughout the world (Bullock & Schomberg, 2000; Yang & Cornelius, 2004). In fact, the rapid development of the Web revolutionises education. In recent times, there is a growing number of online courses being developed using the social constructivist approach (Downing, 2001; Gold, 2001; Young & Norgard, 2006), particularly the social constructivist approach (Vygotsky, 1978; Woo & Reeves, 2007), which encourages students to collaborate and reflect to co-construct new understandings through uniquely personal experiences in the context of inquiry (O'Connor, 1998; Young & Norgard, 2006). From the social constructivist paradigm, one of the potentials of the Web is its ability to encourage interactions and students' involvement in the learning environment (Dillenbourg, 1999; Lavooy & Newlin, 2003; Tsoi, Goh, & Chia, 2000; Woo & Reeves, 2007).

However, Becker (2002) warned that educators should not assume that students would automatically accept and show interests in learning within a social constructivist learning environment. Young and Norgard (2006) further state that how students view the values of learning based on the social constructivist paradigm and their satisfaction and perceptions of online learning environment are important factors to consider to ensure that the online courses offered achieved its objectives. Students' satisfactions toward the courses could influence learning and had an impact on their success in the courses (Arbaugh & Duray, 2002). Hence, research on the effectiveness of online social constructivist learning should investigate the perceptions and satisfactions of students with the learning environment. Furthermore, for effective teaching and learning to occur, the design of the teaching and learning

experiences should take into account students' diverse needs and distinct individual characteristics (Young & Norgard, 2006; Kaufman, 1998). For example, Yang and Cornelius (2004) reported that students who are frustrated with their poorly designed online course reported poor learning outcomes rendering the course ineffective. Thus, in an online learning environment, it is also pertinent to look at the impact of students' existing computer skills on their satisfactions with the course. This is especially important, as research on the relationships between students' computer skills and their satisfactions with online courses have shown conflicting results (Hong, Abang Ekhsan Abang Othman, & Zaimmuarifuddin Shukri Nordin, 2005).

Objectives of study

In this study, the third author developed using a social constructivist approach, an online mathematical problem solving course and 37 teacher trainees from a teacher institute completed the course. The study then looked at the participants' satisfactions and perceptions of the online course. This study also identified aspects of the course that facilitate and obstruct learning processes amongst the course participants.

Literature review

Satisfactions with online courses

Participants' satisfactions toward the learning environment are a critical factor in online learning (Andreatta, 2003). Participants' satisfactions with online courses can attract them to register for the courses and ensure that they complete their studies (Halstead & Coudret, 2000). The study by Blackwell, Roack and Baker (2002), Hong, Lai and Holton (2003), Klinger (2003), Motiwalla and Tello (2000) and Young and Norgard (2006) reported that most participants were satisfied with the online courses and learning environments they had gone through. However, Lauren, Jennifer and Marguerite (2004) in comparing participants' satisfactions with face-to-face courses and online courses reported that generally participants reported higher satisfactions with face-to-face courses.

However, Gallo (2007) and Strachota (2003) reported that participants' characteristics such as gender, age and computer skills could influence students' satisfactions with online courses. However, there are studies that reported otherwise (Hong, 2002; Hong, Lai, & Holton, 2003). Furthermore, Graham, Cagiltay, Lim, Craner, and Duffy (2001), Hiltz, Coppola, Rotter, Turoff, and Benbunan-Fich (2000), Motiwalla and Tello (2000), Sher (2004) and Young and Norgard (2006) also reported that interpersonal interactions and positive feedbacks by instructors impacted positively on participants' satisfactions with online courses. Andreatta (2003) believed that feedbacks with affective components supported students' motivations, which in turn resulted in higher satisfactions. In addition, investigations on the relationships between participants' learning styles and satisfactions with online courses did not yield clear results (Hong, 2002; Klinger, 2003).

Perceptions toward online courses

Hong (2002) and Hong, Liau, and Lee (2006) reported that participants tend to perceive flexibility in course structure as strength of online courses, and they found their learning experiences in these courses to be motivating. In fact, they stated that positive attitudes toward learning, self-discipline and high self-motivations were the basis for their success in online courses. According to Krebs (2004), participants of online courses tend to view online learning environment as enabling them to study at their own pace, to be actively involved in the learning activities, to improve their intrinsic motivation to learn and to practice self-study compared to those attending traditional face-to-face classes. They appreciate the flexibility and the structures in online classes where learning can be carried out individually and independently (Pedone, 2003).

Generally, the literature states that participants of online courses had positive perceptions on the collaborative nature of online learning experiences. They believed that collaborative group activities were interesting and stimulating (Young & Norgard, 2006). Lavooy and Newlin (2003) and Woo and Reeves (2007) further added that the use of unsynchronised communication would yield a more conducive learning environment in the understanding and learning of course materials. However, the study by Curtis and Lawson (2001), which explored collaborative learning in online learning environment, reported differences in collaborative behaviours in face-to-face contexts and online environments and attributed the differences to the lack of the "explain and challenge cycle" which is one of the defining characteristics of face-to-face interactions. Furthermore, William and Purry (2002) reported that participants felt uneasy

during online asynchronous discussion regardless of whether the discussions were optional or compulsory.

Studies on online mathematics/ mathematical problem solving course

Gallo (2007) reported the results of her study on online statistics courses in a university setting. The findings of her quantitative study showed that students participating in online courses generally performed at par with those enrolled in on-campus courses. Age and students' academic ability were found to impact on students' achievement in online statistics courses. Thus, as posited by Allen (1998), students who were strongly motivated, self-starters and intellectually mature were more likely to succeed in online courses. Gallo (2007) further concluded that teaching of mathematics in online courses needed to be connected to the lives and experiences of students.

Kosiak (2004) explored the quality of students' online mathematical communications in collaborative algebra problem solving. He reported that students in the online collaborative group showed co-construction of knowledge and had better scores on a mathematical achievement test compared to the control group. Uribe (2002) investigated case-based approach in solving ill-defined mathematical problems in an online environment and found that there were no significant differences in students' problem solving abilities for the treatment group and control group using systematic approach.

Research methodology

Research design

This study employed the pre-experimental approach without the utilisation of control groups (Creswell, 1994). Quantitative data were collected using questionnaires, while qualitative data were collected through interviews. The questionnaires were used to measure the participants' perceptions of and satisfactions with the course. Additional information was collected during the interview sessions with the course participants. According to Windschitl (1998), qualitative data can capture unique phenomena on online learning.

Research participants

The participants of the study comprised of 37 preservice teachers in the second semester of a one and half year Graduate Diploma in Teaching Program specialising in secondary mathematics education at the Batu Lintang Teacher Institute, Sarawak, Malaysia. They were selected using random sampling from the population of preservice teachers comprising of the July 2004 and January 2005 intakes. From the 37 participants, 11 were female, and 26 were male, all between 20-30 years of age. They rated themselves as being novice and moderate computer users and have only used computers for e-mailing and searching and downloading of information. The participants were on-campus students and they could access the online course using their own laptops or the computers in the laboratories.

Research instruments

Data were collected from the participants using questionnaires and interviews. The questionnaires gathered information pertaining to the participants' gender, age, existing computer and Web skills. The questionnaires also measured the participants' satisfactions toward the course as well as their perceptions on the delivery method, course structure, interactions amongst participants, interactions between the participants and the materials, interactions between the participants and facilitators during computer conferencing and participants' autonomy. Interviews were carried out on all participants upon completion of the course.

The online mathematical problem solving course

The course aimed to provide trainee teachers with the skills to solve mathematical problems based on the Polya's Problem Solving Model (Polya, 1981). The course was a one-credit course carried out in eight weeks between July to September of 2005. At the same time, they were also enrolled in two other courses of one credit each. They were expected to spend around three hours per week in the course, including two hours per week reading the online resources, participating in the online asynchronous discussions and discussing the group assignments, with the remaining hours used for offline activities such as completing assignment individually, self-reading and information gathering.

The participants were required to follow the course online without face-to-face interactions between the course facilitator (third author) and the participants. All communications were done through online asynchronous discussion. The course consisted of three units - Unit 1: Introduction to problem solving; Unit 2: Mathematical problem solving process; and Unit 3: Problem solving strategies. Unit 3 was further divided into four subunits encompassing strategies such as using tables, drawing diagrams, elimination and working backward. The social constructivist learning environment in this online course was developed based on the Jonassen, Peck, and Wilson's Model (1999) shown in Figure 1.

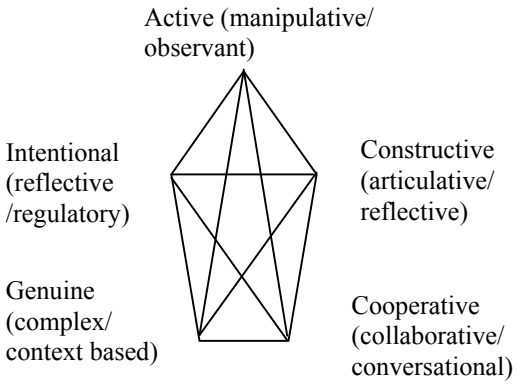

Figure 1: Model of the social constructivist learning environment

This model enabled course participants to be actively involved in meaningful learning and had five characteristics, i.e., active, constructive, intentional, authentic and cooperative. Course materials were uploaded to the Web to allow access at any time. The participants were required to have group discussions for the given authentic assignments and had their works uploaded into a public forum to be discussed by participants from other groups. Assessments were done at the end of the course through a mathematical problem solving test. Figure 2 is an example of authentic group assignments and online asynchronous discussions. These authentic assignments were presented in a manner relevant to the participants' future use and real life applications (Dolmans, Snellen-Balendong, Wolfhagen, & van der Vleuten, 1997; Jonassen, 1997) and addressed the instructional objectives of the course (Dolmans et al., 1997).

A travel agency has a special offer for tourists going to Taman Negara using coaches with the following terms:

- Cost for each ticket is RM100 if all the 15 seats in the coach is filled
- Otherwise, the surcharge per seat is RM5 for each empty seat

How many tickets should the agency sell to maximize its profit for each trip?

Figure 2: An example of authentic problem

For each unit in the course, the participants had to read the reading materials uploaded in the course web site and collaboratively discussed the authentic assignments in groups of four or five using the private online forums. The groupings were decided by the course instructor based on mixed-ability groupings. Completed assignments were posted online to be commented and discussed by other participants. The course instructor facilitated these discussions. These discussions provided opportunities for constructive, reflective, active and cooperative activities involving meaningful discussions within the domain of the online course. While engaging in authentic learning tasks with peers and facilitator, learners generate ideas, share ideas and resources, negotiate, synthesise their thoughts with those of others, complete the tasks and refining them on the basis of further sharing of insights and critiques (Woo & Reeves, 2007). The online course was developed using Coldfusion and a screenshot of the online asynchronous discussions is shown in Figure 3.

Data analysis

Data on the participants' perceptions and satisfactions toward the online course were obtained from questionnaires and interviews. Semi-structured interviews with four focus questions on the participants' views/values, experiences/behaviours and feelings (Patton, 1996) after completing the online course were conducted with all the 37 participants. Follow-up probing questions were presented to obtain more data

from the focus questions. The data were analysed and presented using descriptive statistics (frequencies, means and standard deviations).

Figure 3: Screenshot of the online asynchronous discussion.

Results

Table 1 shows the responses from the participants for two items associated with their satisfactions with the online course. The results showed that 97.3% of the participants agreed that the course had helped them to learn problem solving in mathematics (Mean, M=4.19; Standard deviation, SD=0.46). Furthermore, 91.9% of the participants believed that the online course was a conducive learning environment (M = 4.2, SD = 0.6).

Table 1: Satisfactions with the online course

	Responses						
Items	SA	A	US	DA	SDA	M	SD
I believe that the online course helps me to learn problem solving in mathematics.	8	28	1	0	0	4.2	0.5
I believe that the online course provides a conducive learning environment.	9	25	3	0	0	4.2	0.6

Note: SA = Strongly Agree (5), A = Agree (4), US = Unsure (3), DA = Disagree (2), and SDA= Strongly Disagree (1), M = Mean, SD = Standard Deviation

Perceptions of the course

Table 2 shows participants' perceptions of the various features in the online course. The participants were generally satisfied with the course delivery system (M = 4.0, SD = 0.7) and the course structure (M = 3.9, SD = 0.7). In terms of course delivery system, 97.3% of them felt that the online course was effective for interactive learning, 81.1% felt that the course content was well-delivered and 91.9% experienced enhanced interests in learning. However, only 64.9% reported gaining easy access to technical support during their online learning experiences.

For course structure, 83.8% of the participants felt that the course content was well structured, 86.5% perceived the course assignments to be appropriate, 94.6% agreed that they could actively involve themselves in the learning activities, and 81.1% felt that the course materials satisfied their learning needs. However, only 56.8% were able to access the course content without the constraints of time and place. Interviews with the participants showed that 10.8% of the participants did not own a computer and they could only access the course materials from the Teacher Institute's computer laboratories.

Table 2: Perceptions of the course delivery system and course structure

Items	Feedbacks						
	SA	A	US	DA	SDA	M	SD
Delivery system							
I believe that the online course is an effective means for interactive learning	11	25	0	1	0	4.2	0.6
I believe that the online course contents are well delivered	4	26	5	2	0	3.9	0.7
The online course enhances my interests toward learning	11	23	2	1	0	4.2	0.7
It is easy to gain access to technical supports	3	21	10	3	0	3.7	0.8
(For these four items, M = 4.0, SD = 0.7)							
Course Structure							
I believe that the online course contents are well structured	3	28	5	1	0	3.9	0.6
I believe that the tasks assigned are reasonable	7	25	4	1	0	4.0	0.6
I am able to access the course content without the constraints of time and place	3	18	9	7	0	3.5	0.9
I can actively involve myself in the learning process	8	27	2	0	0	4.2	0.5
I believe that the course materials satisfy my learning needs	2	28	6	1	0	3.8	0.6
(For these five items, M = 3.9, SD = 0.7)							

As shown in Table 3, the participants generally had positive attitudes toward individual learning in the online course (M = 4.1, SD = 0.6). Majority of them (91.9%) agreed that they were able to determine their direction of learning in the course, 83.8% could obtain the learning resources from the library and the Internet, 75.7% could complete the learning tasks on time, 97.3% preferred to study at their own pace, 86.5% liked to be actively involved in group discussions, 91.9% valued the facilitator's contributions in the learning process and all of them believed that discussions with other course participants formed an integral part of their learning in the course.

Table 3: Perceptions of learning autonomy

Items	Responses						
	SA	A	US	DA	SDA	M	SD
I can determine the direction of my study	7	27	3	0	0	4.1	0.5
I can obtain the materials from the library and Internet for learning	7	24	5	1	0	4.0	0.7
I can complete the task assigned within the time given	4	24	6	3	0	3.8	0.8
I like to study at my own pace	9	27	0	1	0	4.2	0.6
I like to involve myself actively in group discussions	7	25	5	0	0	4.1	0.6
I appreciate the contributions from the facilitator toward learning in the course	11	23	3	0	0	4.2	0.6
I believe that discussions with other course participants are part of the learning experience	15	22	0	0	0	4.4	0.5
(For seven items, M = 4.1, SD = 0.6)							

The following results were obtained through feedbacks from participants during interviews on their perceptions toward the online course.

Design of Web pages and course activities

Generally, the participants felt that the Web pages were well-designed, complete and easy to access. A participant stated that the "designs were interesting, yet simple and it allowed users easy access to information in the Web page." The participants also observed that the learning materials, such as the course notes and assignment questions were complete and easy to access. The findings from the interviews suggested that the participants believed that the course activities fitted well with the course

objectives and helped them to master the required problem solving skills. Specifically, a participant reported that "the activities carried out were suited to the competency levels of the participants, and the objectives of the course were attainable." Furthermore, some of the participants felt that the course activities were interesting and managed to inculcate creative thinking and could stimulate their interests in mathematics.

Course delivery, course structure, flexibility of courses and new learning experiences
A participant pointed out: "It was an interesting, interactive and friendly learning environment. It allowed participants easy access to information." The participants also believed that the course helped them to think systematically, logically and critically. They viewed the flexible nature of the course as an advantage for them. They were able to follow the course without the constraints of time and place. "I was able to access the course regardless of where we were insofar as there are Internet networks," commented a participant. They felt that the online course was an interesting and new learning experience, enjoyable and motivating.

Positive attitudes, self-discipline and students' autonomy
The participants believed that they required positive attitudes to succeed in online learning and in fact, the course did inculcate some of them with positive self-attitudes. For instance, one of the participants believed that the "course instilled positive attitudes and we were able to overcome many problems encountered. The course also emphasised on knowledge sharing and encouraged us to share information." Apart from that, the participants believed that they need to have self-discipline to succeed in the course, as a participant emphasised: "The course tested our self-discipline because participants' concentrations could be easily diverted when we did not meet the facilitator face-to-face. Furthermore, participants could stray from the course Web site and surf unrelated Web pages in the Internet." The self-paced and self-access mode of learning made them more independent in learning, as one of the participant aptly observed, "The course helped the participants to become independent and this was important because there were participants who could be at remote areas, far from the facilitator."

Role of facilitators and authentic problems
The interviews suggested that the participants in general believed that the facilitator was effective in facilitating the course activities. Amongst others, a participant stated that "the facilitator would assist us when we faced problems in solving mathematical problems." They also viewed that the use of authentic mathematical problems related to their daily lives assisted them in understanding the course content and enhanced their critical thinking skills as shown in the following comment, "I felt that I have become more critical in solving mathematical problems and also I could understand the different aspects of problem solving through interacting with other participants."

Interactions in the online asynchronous discussion

As Table 4 shows, on the whole, participants were satisfied with the effectiveness of group discussions in the online asynchronous discussion (M=4.1, SD=0.7 for the five items on "small group dynamics"). Specifically, 72.9% agreed that group discussions during the online asynchronous discussion function effectively, 83.8% believed that the group discussions enhanced their understanding of mathematical problem solving process, while 91.9% felt that they could contribute to the group discussions. Furthermore, 97.3% of the participants stated that they were able to learn from the other participants, while 91.9% agreed that the group size of 5-6 participants was ideal for group discussions.

Participants were generally satisfied with the role of the facilitators in computer conferencing (M=4.0, SD=0.8, for the five items in the "role of course facilitators/ participants"). Specifically, 83.8% of the participants agreed that the facilitators had succeeded in encouraging group learning through questioning, challenging and providing appropriate criticisms. Another 94.6% felt that they could obtain assistance in understanding the content of the course, 64.9% believed that they were able to obtain the necessary information from the facilitator as frequently as they required it, 67.6% were satisfied with the interactions between participants and facilitators, while 91.9% felt that the content of the discussions amongst participants enhanced their learning.

As a whole, most of the participants were satisfied with the learning materials used in the online asynchronous discussion sessions (M=4.1, SD=0.6 for the three items on "learning materials"). Besides enabling participants to understand the course content (97.3%), the participants' comprehension of the

mathematical problem solving process was enhanced by studying the problems (89.2%) and course materials online (89.2%).

Table 4: Perceptions of the dynamics of small groups, role of facilitators, and learning materials used in online asynchronous discussion

Items	Responses						
	SA	A	US	DA	SDA	M	SD
Small group dynamics							
On the whole, my discussion group functions effectively	9	18	6	4	0	3.9	0.9
The group discussion enhances my understanding of the mathematical problem solving process	7	24	5	1	0	4.0	0.7
I can contribute to the group discussion	5	29	2	1	0	4.0	0.6
I can learn from other students in group discussions	11	25	0	1	0	4.2	0.6
The group size is appropriate for discussions	15	19	1	2	0	4.3	0.8
(For these five items, M = 4.1, and SD= 0.7)							
Role of Facilitators/ Course Participants							
The facilitators encourage group learning through questions, challenges and criticisms	8	23	6	0	0	4.1	0.6
I obtain feedbacks from facilitator as frequent as I need them	6	18	10	3	0	3.7	0.8
I could interact with the facilitator as frequent as I need them	6	19	9	3	0	3.8	0.8
I could obtain assistance to understand the content of the course	6	29	1	1	0	4.1	0.6
The content of discussions amongst the participants could enhance my learning	12	22	1	1	1	4.2	0.8
(For these five items, M = 4.0, SD = 0.8)							
Learning materials							
I can understand the course content	6	30	1	0	0	4.1	0.4.
Paying attention to the mathematical problem enhances my understanding of the problem solving process in mathematics	9	24	4	0	0	4.1	0.6
The use of materials in the course enhances my understanding of the mathematical problem solving process	9	24	3	1	0	4.1	0.7
(For these three items, M = 4.1, SD = 0.6)							

The following results were obtained from participants' feedbacks during the interview sessions.

Sharing of knowledge, collaborative activities and active involvement in computer conferencing
The online asynchronous discussion provided the participants with the opportunities to exchange opinions and share ideas and in the process improved their learning experiences. For instance, one of the participants felt that "the most important aspect of the online course was the online asynchronous discussion where they were able to exchange and give opinions." They also had the opportunities to carry out collaborative activities with other participants, as one of them stated that "the course provided opportunities to discuss, to share information as well as learning through collaborations."

Enhancement of computer skills and motivation to learn
Some of the participants perceived that online asynchronous discussion could enhance their computer skills. A participant noted that "My computer skills were enhanced after completing the course." The participants believed that online asynchronous discussion was able to increase their motivations and interests in learning. For instance, one of the participants stated that "it was as though we were competing amongst ourselves to solve the given tasks, each wanting to become the earliest to present the answers. The course was interesting and I was motivated to learn."

Factors influencing the effectiveness of online asynchronous discussion
The participants outlined seven factors they believed could contribute to the effectiveness of online asynchronous discussion. They were of the opinion that active involvement and cooperation amongst participants played an important role in determining the effectiveness of online asynchronous discussion. They felt that participants need to have positive attitudes toward online asynchronous discussion to achieve the objectives set for the online asynchronous discussion sessions. Some of them felt that individual differences in terms of the ability levels could influence progress in the course and that the rate of feedbacks from fellow participants influenced their learning and interests in studies. Good computer skills could assist them in the course.

Aspects of the course that hinder learning
From the interview, seven weaknesses hindering learning were identified. A small number of the participants felt segregated while following the online course. Some of the communication problems faced by the participants were difficulties in explaining and understanding of the mathematical solutions via online asynchronous discussion, availability of sufficient computer facilities, and technical problems related to the computer server such as unavailability and problematic speed of network connections, as well as difficulties in up- and down-loading of files. Majority of them would like to equip themselves with the basic computer skills, such as "Microsoft Word," "Excel," "Equation Editor," and graphic software in order to follow the course effectively.

Discussion

The study reported high level of satisfactions toward the online course. This is consistent with the findings of most studies on Web related courses in the literature (Hong, 2002; Klinger, 2003; Young & Norgard, 2006).

Consistent with the findings reported by Hong (2002), Hong, Lai and Holton (2003) and Klinger (2003), course flexibility was one of the reasons participants were satisfied with the online course. Likewise, as stated by Hong (2002), the participants in this study believed that they must have positive attitudes, self-discipline, ability to work independently and self-confidence to succeed in the course. Furthermore, they need to have intrinsic motivations to take part in the activities designed in the online course including completing the assignments, reading the course materials and participating in the online asynchronous discussion and this was consistent with the results reported in Gallo (2007) and Roberts (2003). Participants of the course also pointed out that the online course provided them with the opportunities to discuss, share information and carry out collaborative learning through online asynchronous discussions. Via online asynchronous discussion, they were able to interact with fellow participants and the facilitator at any time and place. In general, the participants were satisfied with the interactions amongst participants and with the facilitator. In fact, most of them would like to be actively involved in the online asynchronous discussions and believed that discussions with other participants were important for their success in the course. Nonetheless, as reported in Matuga (2001), some of the groups may have better group dynamics resulting in more frequent and more quality discussions compared to other groups.

The literature also reported other factors that could impact on learning in online courses such as accessibility to course materials and frequencies, immediacy and length of feedbacks from the instructors (Hong, Liau, & Lee, 2006; Lauren et al., 2004). Likewise in this study, the participants reported that they were able to interact and obtained feedbacks from the facilitator as frequently as they required. For them, the moral support and assistance provided by the facilitator were some of the factors that contributed to their satisfactions with the course and these findings were also reported by Andreatta (2003). Although online asynchronous discussion encouraged collaborations and learning in the online learning environment, it was not without problems. For instance, participants became disappointed because they were not given feedbacks within reasonable time frame from other group members and some of the participants were not actively involved in the discussions.

Nearly two thirds of the participants agreed that the interface design of the Web page was user friendly, simple and attractive. In addition, they found that the course content to be well organised, notes easy to refer to, and files could be easily uploaded and downloaded. They also felt that the course activities suited the course objectives and the competency levels of the participants. Furthermore, these course activities were able to enhance their interests toward mathematics and encouraged them to think critically. The study also showed that most of them preferred to study with self-access and at their own paces. As reported in Hong (2002) and Hong, Lai, and Holton (2003), the participants believed that the course not only helped them to enhance their mathematical problem solving skills, it also enhanced their computer skills and knowledge.

However, a small number of participants felt isolated while completing the online course. This could be attributed to the lack of face-to-face interactions and as reported in the literature, participants lacking learning experiences with online courses require more assistance from facilitator compared to experienced participants (Chang, 2003). Some of the participants experienced technical problems while using the Web pages and computers including server and computer breakdowns, Internet disconnections, and problems related to uploading and downloading of files from the Web pages as similarly reported in Hong (2002). Some of them also found it cumbersome to explain mathematical problem solving through online asynchronous discussion, especially if their computer skills were lacking as sometimes diagrams and mathematical equations were required to facilitate the discussions.

Conclusions

The study examined the participants' satisfactions and perceptions of an online mathematical problem solving course designed using a social constructivist approach. Participants generally provided positive feedbacks on the online learning environment though they were faced with challenges, problems and constraints in attending the course. Most participants were satisfied with the designs, materials and course activities, interactions and communications amongst participants as well as the role played by the facilitator. In fact, they believed that these factors helped in their studies. In sum, the online mathematical problem solving course using the social constructivist approach were appropriate and ought to be given serious attention and could be seen as an alternative to traditional classes. However, educationists should take the pedagogical considerations seriously in designing and implementing online courses to minimise problems that participants might encounter while participating in such courses.

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