Online Supplemental Instructions – An Alternative Model for the Learning of Mathematics

[1]Richard Ng; [2]Abtar Kaur; [3]Latifah Abdol Latif
Open University Malaysia
[1]richard_ng@oum.edu.my
[2]abtar@oum.edu.my
[3]latifah@oum.edu.my

Abstract

More than 90% of Open University Malaysia (OUM)'s learners are working adults who are unable to leave their jobs or families behind to pursue their dreams of getting a degree. The blended learning mode adopted by OUM provides the flexibility for working adults to obtain their paper qualifications and to upgrade their knowledge. Mathematics, a traditionally difficult course, forms part of the pre-requisite for learners to obtain a business degree at OUM. The adult learners at OUM generally have left school for at least five years and most of them have low grades in Mathematics at O' Level. Thus it is a big challenge for these adult learners to undertake a Mathematics course via online with minimum Face-to-Face contact with their tutors.

This paper proposes an alternative model of learning mathematics known as Online Supplemental Instruction (OSI) model which involves three components; pre-tutorial workshop, online mentoring, and online video support. The research which involved 132 learners under the tutorship of two tutors was carried out to find the impact of the model on learners' online participation and final exam score. The contents of the online discussion forum were analyzed using a 34-item instrument derived from the Community of Inquiry (COI) model. Learners' online participation behavioral pattern was also analyzed. Results obtained showed that there was a strong correlation between learners who have participated in the OSI model of learning and their online participation and final exam score.

***Keywords:** Online Participation, Mathematics, Community of Inquiry, Mathematics, Supplemental Instruction, Collaborative Online Learning, Weblog, Online Mentoring, Video support*

Introduction

The online discussion forum is one of the three key components of a blended learning pedagogy used at Open University Malaysia (OUM), Malaysia's first open and distance learning university with over 80,000 students who are mostly working adults. The online discussion forum, which is part of the Learning Management System (LMS), enables learning to be expanded beyond classroom without barriers of space and time.

For a working adult who has left school for more than five years, coming back to school to take up math course is a big challenge, what more if he/she has to do it via blended learning pedagogy with minimum face-to-face contact hours. Math has traditionally been regarded as one of the very difficult subjects. The situation becomes worse when learners find difficulties in posting their problems via LMS as the system does not support mathematical symbols and they are not familiar with the Equation Editor software for instance, that supports mathematical symbols. Some of these learners may also be hampered by technological problems due to their incompetence in handling the computer and Internet. Hence the grade of these learners will be affected and this may impact on their intention to stay in their programs.

In order to overcome these problems, OUM has embarked on a pre-tutorial workshop as part of the Online Supplemental Instructions (OSI) model of learning aimed at providing basic foundation in

math to all learners taking up the math course. Learners will be invited to attend this workshop where they will be taught on how to access the LMS as well as handling the Microsoft Equation Editor software, which can help them type mathematical symbols for online discussion. Learners undergoing math course will also be guided via online mentoring by their peers where questions will be posted and certain learners who are good at math will provide solutions and explanations facilitated by their tutors. Learners will also be provided sample video clips posted in the YouTube and organized in a Weblog.

Research Objectives

As OUM aspires to become a mega university by 2010, retention of students has become one of the critical success factors. Mathematics has been regarded by many as one of the difficult subjects. Open and distance learners often find it difficult to post up questions and respond to questions posted by their tutors via online because they are limited by their inability to post mathematical symbols. As a result, learners will find it difficult to use the Learning Management System as a tool for them to assist in their learning and this may have impact on their final exam score. Learners who are not engaged in the learning system may drop out from their studies.

The main objective of this research is to find the impact of the OSI model on learners' online participation ratio and final exam score.

The following questions were used to guide the research:

a. Was there a significant difference in the online participation ratio between learners who have participated in the OSI model of learning and learners who have not?

b. Was there a significant difference in the final exam score between learners who have participated and learners who have not participated in the OSI model of learning?

c. Was there a difference in the COI mean score between learners who have participated in the OSI model of learning and those who have not?

d. How was the participation behavioral pattern of learners attached to tutor using the OSI model of learning and learners who were not?

The OSI Model Description

Figure 1 below shows the OSI model used as an alternative model in the learning of Mathematics by open and distance learners. The limited contact hours during face-to-face session necessitates the used if this model to extend learning beyond classroom.

According to this model, learners must first be trained to use special software known as Ms-Equation Editor to assist them to type mathematical symbols required for online posting and discussion. This is conducted as a pre-tutorial workshop prior to the first session of the tutorial. A video on how to use this software will also be posted in the Youtube and organized in a Weblog.
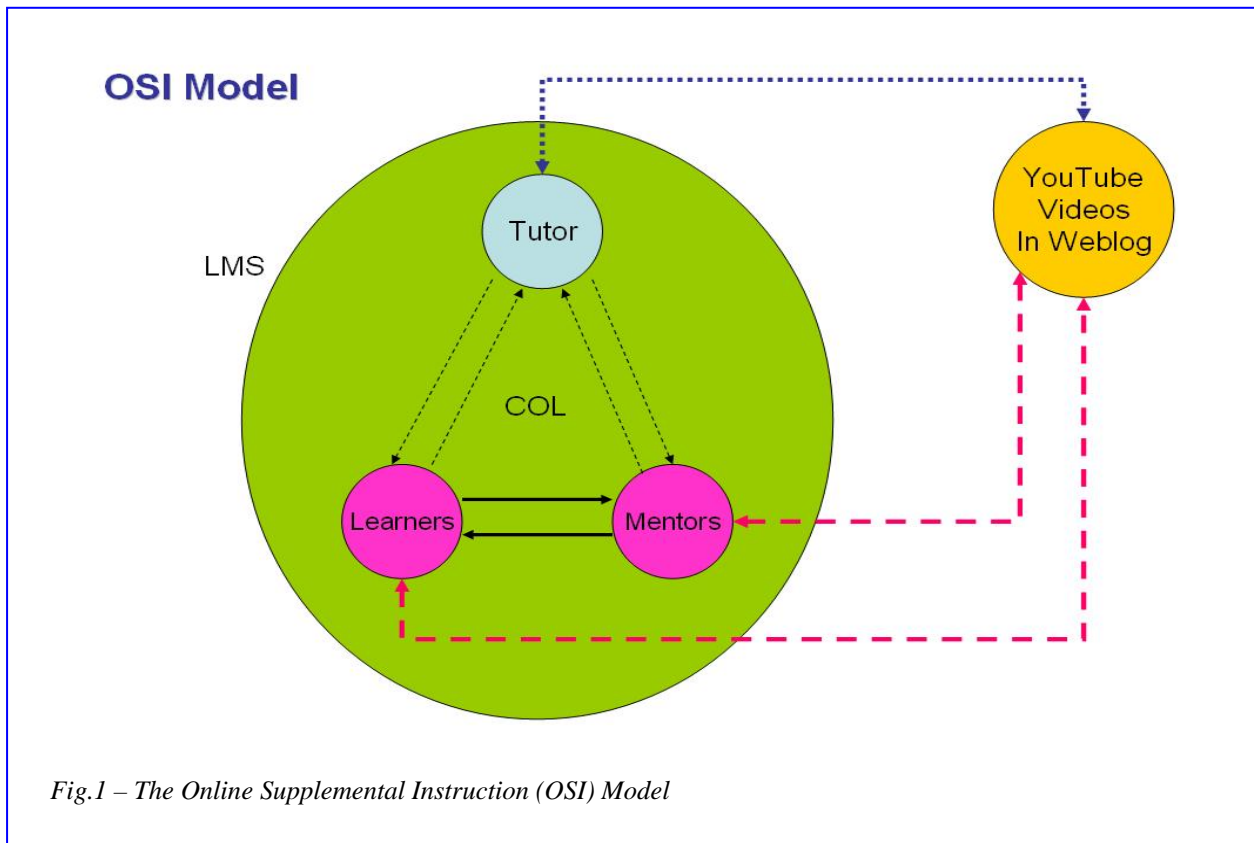
OSI Model

Fig.1 – The Online Supplemental Instruction (OSI) Model

During the initial stage of learning, the tutor will post some questions to gauge learners' math level so that learners who are good in math as well as handling the software will be identified and appointed as mentors. Other weak learners will be informed about this so that they can address the mentors during online discussion.

The tutor will then post questions and assigned each mentor to handle each question posted. Mentors will then encourage course mates to post or answer question posted and provide comment and guidance while the tutor observe all the online discussion taking place in the forum. The tutor will also post short videos on samples questions and answers related to questions posted for discussion. The process will continue until the semester ends.

Thus, the tutor is responsible to post exercises and get mentors to help moderate the answers while the tutor observes the online discussion forum. Learners who are inactive will be constantly reminded to participate either by posting solutions or downloading the solutions provided and acknowledge they have read and understand the contents posted.

The Weblog mentioned above can be viewed at: http://bbmp-1103.blogspot.com

Literature Review

As Open and Distance Learning mode is gaining popularity, there are many comparative studies conducted over the last few years. Russell (2001, 2005) in his research opined that there is no significant difference between learning that takes place in a traditional environment versus distance education. This was supported by Neuhauser (2002) who found that course delivery media was not sufficiently significant to affect course outcomes. Tatum (2000) in his ABC Theory (Affirm identity, Build community and Cultivate leadership) opined that every learner in a learning environment needs a supportive climate of achievement.

Many believe that technical subjects including mathematics cannot be delivered 100% via online. According to Engelbrecht and Harding (2004), this could be due to the inability of the Internet Hypertext Markup Language (HTML) to represent mathematical symbols and also the general belief that mathematics can only be taught successfully via face-to-face approach. Mathematics has been regarded by learners historically as one of the many difficult courses or "high-risk" courses due to its low success rate in completion.

Weems (2002) conducted a comparative study on the Introductory Algebra subjects offered to two groups of students; one taught via online and the other via traditional approach. He found that there is no significant difference between the achievements of both groups of students. A similar research conducted by Ryan (2001) on the Introductory Mathematics subject also yielded the same result. However, Russell (2006) found that there is a significant difference between the final grades for the Introductory Mathematics course for online and traditional students and that the mean grade for online students are lower than the mean grade of traditional format students.

Lotze (2002), in his comparative study on the teaching of mathematics and statistics via face-to-face and online, found that students in the online learning mode not only struggle with the mathematics concept but also hampered by the use of mathematical symbols, which is necessary to understand and explain the concept. Thus, it is important to introduce both the basic concepts of mathematics and how to use software such as Microsoft Equation Editor to communicate these symbols to beginners, especially adult learners.

Math has been regarded by learners historically as one of the many difficult courses or "high-risk" courses due to its low success rate in completion. Many learners are not prepared for higher level of studies and do not know how to study (Martin & Arendale, 1993). According to Hodges (2001), institutions now turn to supplemental instruction (SI), one of two forms of academic assistance besides tutoring to help students succeed in their studies. The education innovative SI was developed by Deanna Martin in 1973 at the University of Missouri in Kansas City. Many researches conducted on SI have shown significant results where it does influence grades and even retention (Phelps, 2005 & Doty, 2003).

According to Lotze (2002), adult learners returning for academia after a long absence often experience high level of discomfort with technology. Thus, many Online Distance Learning (ODL) institutions introduced orientation programs to improve on their learners' readiness in ODL learning. According to Pillay, Irving and Tones (2007), many institutions that adopt online learning have very little regard on pre-requisite personal and technicalities required by students for academic achievement and satisfaction, which are predictors of retention. Though the level of technical skills with regard to using and navigating in online learning does not directly affect students' achievement, they do influence their engagement with technology.

SI offered via online can become a tool for collaborative learning experience. The Community of Inquiry (COI) model provides a means to study online learning and teaching to find out if collaborative learning is achieved. According to Garrison, Anderson and Archer (2000), the key component of COI is collaboration with regard to engaging students in an online learning environment. He suggested that a sense of community takes time to form but once it is formed, it will become a powerful learning catalyst and support for the learning community. Creating and sustaining this community is framed by the three core elements of a community of inquiry: social presence, cognitive presence, and teaching presence. (See Fig. 2).
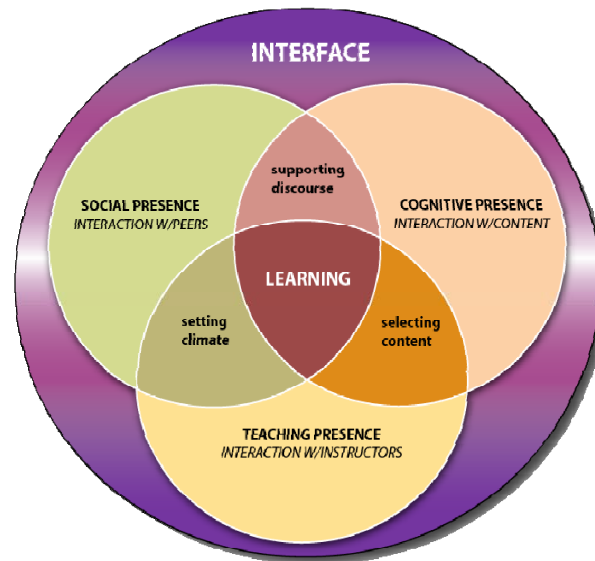
Fig. 2 – The Community of Inquiry Model (Garrison, Anderson & Archer, 2000)

Garrison, Anderson and Archer (2000) opined that online learning occurs through the interaction of three domains; Social Presence, Cognitive Presence and Teaching Presence.

- *Social presence* reflects the ability to connect with members of a community of learners on a personal level.
- *Cognitive presence* is the process of constructing meaning through collaborative inquiry.
- *Teaching presence* is the crucial integrating force that structures and leads the educational process in a constructive, collaborative and sustained manner.

Abtar (2004) noted that students' participation is often minimal without an instructor's participation. She suggested that planned, focused and guided online discussions can result in successful learning experience. Providing feedback especially encouraging comments, pointing out errors and correcting them and using leading questions in an online discussion helps in guiding and directing students to follow and continue their posting. She added that providing timely feedback is important as questions posted by students left unanswered for too long will discourage posting.

The SI concept, which involved face-to-face coaching by experienced learners, can be expanded into online forum with proper software and coaching and turned into a collaborative learning experience. Ng and Wagner (2007) in their research found that the participation of learners increased to 84% from 64% (Abtar, 2004) with the introduction of Collaborative Online Learning (COL). The learner's average hit rate is generally higher for COL courses compared to non-COL courses. Fadzil (2005) has proposed five critical success factors in developing online learning, one of which is the human factor – by developing a new learning culture where learning must be learner centered, interactive and engaged in a collaborative online learning.

Collaborative learning brings participants together in some kind of social interaction where they feel they are more involved and thus learns more effectively. Online tutors play an important role in reassuring learners the support, making learners feel they have a good rapport with their tutors and that they are being assessed and guided (Hofmann, 2004).

Ng (2008) in his research on tutors and learners' participation in the online discussion forum found that most of the posting made for mathematics course happened during the first four weeks of

participation and gradually reduced from midway toward the end of the course. He opined that such behavioral pattern is due to technological barriers faced by both tutors and learners. For COL to take place in expanding teaching of mathematics into online, learners and tutors must be equipped with the technological know-how as well as some basic foundations in that subject.

Research Methodology

The research involved 132 learners under the tutorship of two tutors – Tutor R and Tutor S. Tutor R was involved in using the OSI model (Treatment Group) and Tutor S used the normal tutorial session (Control Group).

The research involved three phases:

a) First Phase – Pre-Tutorial Workshop

   i. Learners who are taking the Management Mathematics course were invited to attend a workshop on how to use the Ms-Equation Editor software and how to post questions and answers, two weeks before the first face-to-face tutorial session.

   ii. Learners were also given a refreshment course on basic mathematics. They were then divided into small groups of between 4 to 5 learners and each group is given a mathematic question to solve. The leader of each group was asked to present the group's solution.

   iii. Facilitator of the workshop will then point out the correct steps in solving the question

b) Second Phase – Online Mentoring

   i. The tutor who is also the online facilitator identified mentors among the learners by asking learners three simple questions as follows:

- What was your math's grade at O' level?
- How do you rate your math's level at the moment?
- What is your goal for this course?

   ii. The Tutor then posted some mathematics questions and observed the answers submitted by the learners.

   iii. Learners who have submitted good answers were then asked to moderate questions posted by the tutor. They also acted as mentors for other weaker learners.

   iv. Short video clips with sample questions and answer were posted in the Weblog (http://bbmp-1103.blogspot.com) and learners were told to use it to assist them in answering the questions posted.

c) Third Phase – Data Collection and Analysis

   i. At the end of the fifth (final) tutorial, Tutor R and Tutor S submitted the Online Monitoring results provided by the System Admin software of the LMS.

   ii. The average number of posting made by the learners and the tutors were tabulated using Ms-Excel to produce a chart to produce the online participation pattern.

iii. The online participation ratio was generated by dividing the Online Participation (OLP) marks given by the tutor with the number of posting made by each learner

iv. The content of the online discussion forum was analyzed using a 34-item questionnaire obtained from the COI model

v. At the end of the semester the final exam score of each learner is obtained from the Exam Unit of OUM and the mean score of the learners were analyzed

Findings

a. Samples

Out of the 132 learners involved in the research of which, 82 of them were tutored by Tutor R and 50 by tutor S. The breakdown of their Math grade at O' level is as shown in Table: 1

Table: 1 – Samples distribution

Tutor	Learner's Math Level		Total
	Grade C & above At O' Level	Grade below C At O' Level	
R	30	52	82
S	28	24	50
Total	22	60	132

b. Terms and Definition

- The Online Participation ratio is obtained by dividing the number hits posted by a learner with his/her online participation marks.
- Final Exam Score refers to the marks obtained by learners during the semester final examination
- Tutor R used the OSI model of teaching whereas Tutor S used the normal way of teaching.
- O' level refers to the GCE O' Level equivalent examination
- Grade C and above refers to a exam marks of 50 and above
- The average number of hits of online participation is obtained by dividing the number of hits made with the number of learners attached to a particular tutor

c. Results

The following are the findings of the research:

i. *Was there a significant difference in the online participation ratio between learners who have participated in the OSI model of learning and learners who have not?*

Table 2 below shows the mean ratio of learners under the tutorship of Tutor R and Tutor S. It can be noted that the mean ratio of the learners' online participation in the forum is higher for learners under Tutor R (mean = 13.79) compared with learners under Tutor S (mean = 2.17).

Table: 2 – Comparison between the Mean Score of the Online Participation Ratio of learners under the tutorship of Tutor R and Tutor S

OLP Ratio	N	Mean	Std. Deviation	Std. Error Mean
R	82	13.79	11.81	1.64
S	50	2.17	1.50	0.25

Table 3 below shows the results of Independent Sample T Test carried out on the Online Participation Ratio. The alpha values obtained were less than 0.05 indicating that there is a significant difference in the Online Participation Ratio between learners under the tutorship of Tutor R and Tutor S.

Table: 3 - Independent Sample T Test carried out on Online Participation Ratio for learners attached to Tutor R and Tutor S respectively

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
OLP Ratio	7.01	53.37	0.00	11.62	1.66	8.30	14.95

ii. *Was there a significant difference in the final exam score between learners who have participated and learners who have not participated in the OSI model of learning?*

Table 4 below shows the mean of the final exam score between learners attached to Tutor R and Tutor S. The results showed that the mean final exam score for learners under Tutor R (mean = 20.01) is higher Tutor S (mean = 10.81).

Table: 4 – Comparison between the Mean Final Exam Score of learners who are under the tutorship of Tutor R and Tutor S

Final Exam	N	Mean Score	Std. Deviation	Std. Error Mean
R	82	20.01	17.67	2.45
S	50	10.81	9.15	1.53

Table 5 below shows the results of Independent Samples T Test carried out on final exam score. The results showed that the alpha value obtained is less than 0.05 indicating that there is a significant difference between the final score of learners who have undergone the OSI model of learning.

Table: 5 - Independent Samples T Test carried out on Mean Final Exam Score for learners attached to Tutor R and S respectively

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Mean Exam Score	3.19	80.56	.002	9.20	2.89	3.45	14.94

iii. *Was there a difference in the COI mean score between learners who have participated in the OSI model of learning and those who have not?*
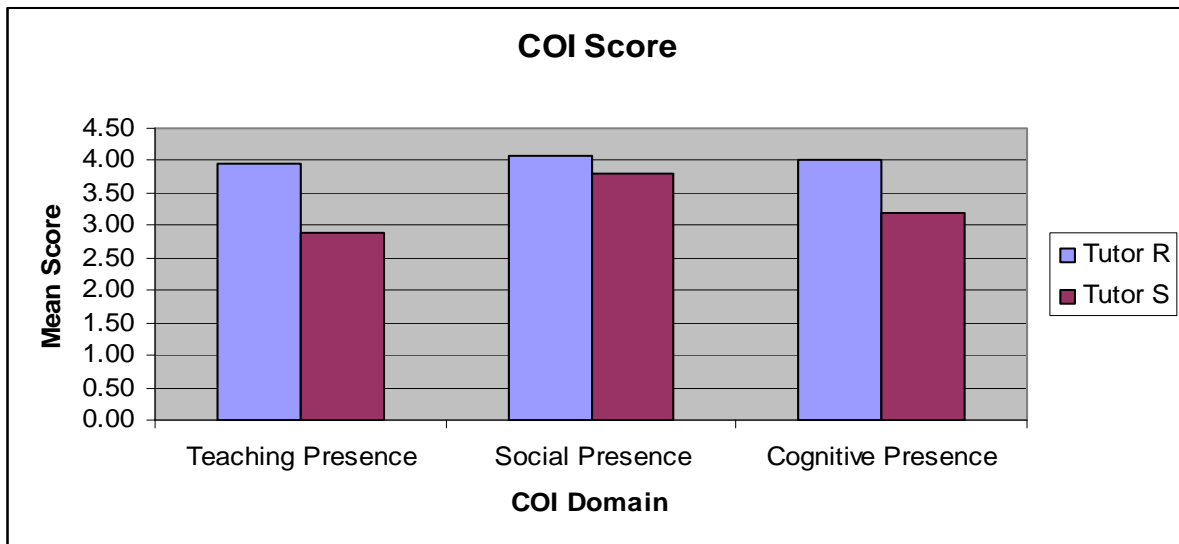

Fig. 3 – COI Mean Score comparison between Tutor R and Tutor S

From figure 3 above, it is noted that the overall COI score is generally higher for Tutor R compared to Tutor S. The OSI model has also created a higher teaching and cognitive presence for learners attached to Tutor R

iv. *How was the participation behavioral pattern of learners attached to tutor using the OSI model of learning and learners who were not?*

Figure 4 below shows the Online Participation pattern of learners under the tutorship of Tutor R and Tutor S. Note that the average number of hits for each category of activity recorded is higher for learners attached to Tutor R compared to Tutor S.
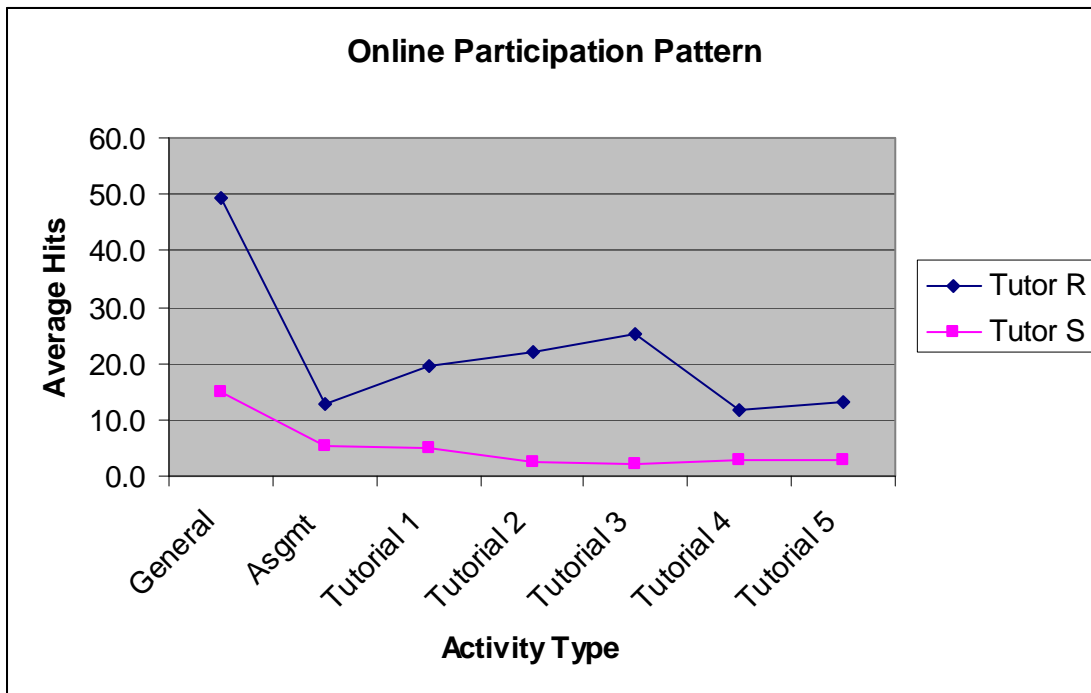
Fig. 4 – Online Participation Pattern of Learners attached to Tutor R and Tutor S

Conclusion

The OSI model has a positive impact on learners' online participation and final exam score. Learners attached to tutor R, who applied the OSI model in teaching math, showed higher online participation ratio and final exam score compared with other learners taking the same course. The mean COI score obtained showed that the OSI model has an impact on the learners' teaching, social and cognitive presence, which form the collaborative online learning (COL).

This pre-tutorial workshop conducted as part of the orientation program and the extended coaching via online which act as supplemental instruction (SI), have proven to provide academic assistance to these learners to succeed (Hodges, 2001). The results obtained in this research support the study conducted by Dash (2004) and Russell (2006) that supplemental instruction does improve the achievement of the learners significantly.

Recommendations

This is an important study for OUM as well as other Open and Distance Learning providers. The model developed could help reduce barriers of technology necessary to enhance learning over a distance. The online supplemental instruction can help improve learners' participation in online discussion forum where most of the learning takes place beyond classroom. Engaged learners will not feel isolated thus reduce attrition rate. Learners' confidence and satisfaction will also increase and this will have impact on their final exam score.

In a nutshell, the model is expected to increase the quality of learning output as follows:

- Improved final exam score
- Increased Confidence Level
- Increased Motivation Level

- Increased retention rate
- Increased OLP ratio
- Increased number of successful graduates

However, the research has its limitation. It assumes that every cohort of learners will have certain number of learners who are good to be mould as mentors. Tutors involved in implementing this model of teaching must be equipped with the necessary ICT skills. They must also spend time in the online discussion forum to monitor to progress of the mentors appointed in order to guide and motivate them.

Open and distance learning providers must find ways to ensure all their learners attend the pre-tutorial workshop. For learners who are from remote areas and are unable to attend the workshop, they can view the video clips posted on the Weblog. However, these learners must have the desire to learn and equipped with Internet and other tools necessary to view the video.

It is also recommended that the research will continue to find if there is any significant difference in the final exam score between learners with math grade at O' level above C and below C after undergoing the OSI model.

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