UNIVERSITI PUTRA MALAYSIA

PREDICTIVE MODEL FOR LEARNING PRODUCTIVITY IN A COMPUTER-SUPPORTED COLLABORATIVE LEARNING PLATFORM AMONG STUDENTS IN A MALAYSIAN PUBLIC UNIVERSITY

SITI HARYANI SHAIKH ALI

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June 2015

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This study was conducted to develop a predictive model of the learning productivity of the students collaborating in the CSCL platform. This study integrates three main theories and two models, namely; Transactional Distance Theory, Social Presence Theory, Online Collaborative Learning Theory following the Constructivist School of Thought, Input-Process-Output Model and The Learning Productivity Model.The independent variables were the students' self-construal, students' prior CSCL experience and technology's usability. The learning productivity was measured by the learning performance, learning gain and learning satisfaction of the students. The level of collaboration was examined as the mediating factor between the independent and dependent variables. The level of collaboration was analysed via quantitative discourse analysis.

In this descriptive survey study, the survey was administered using a questionnaire, adapted from previously validated scales. The validity of the instrument was approved by a panel of subject-matter experts. A pilot study was rendered on 24 undergraduate students which yielded Cronbach's alpha coefficient ranging from 0.87 to 0.3 indicating good reliability. Data were then gathered from 103 undergraduate distance learners, who formed 24 different groups from 11 subjects, selected using cluster sampling. From discourse analysis, 12 groups were found to be highly collaborative among each other, where they had participated in the online discussion roughly equally among each other. Multiple regression analysis was conducted to identify the predictors of the highly collaborated groups (12 groups, n=43). Structural equation modeling (SEM) was employed to test the overall fit for the proposed model (24 groups, n=103).

The current study produced several significant findings apart from generated a model predicting the learning productivity of distance learners in a computer-supported collaborative learning platform. Five out of seven hypotheses were supported where the

paths were proven significant. The significant paths were: 1) students' self-construal has a significant effect on the levels of collaboration of the distance learners (β=-0.743, p>.001); 2) prior CSCL experience has a significant effect on the levels of collaboration of distance learners (β=-0.610, p<.001); 3) technology's usability has a significant effect on the levels of collaboration (β=-0.651, p<.001); 4) the levels of collaboration have a significant effect on the learning productivity of the distance learners (β=.45, p<.001); 5) the levels of collaboration have a full mediating effect on prior CSCL experience and learning productivity (β=-0.642, p<.001). The negative standardized estimates were due to the highest level of collaboration was represented with score 1 and vice versa.

However, two hypotheses were not supported, which were: 1) the levels of collaboration did not have a full mediating effect on students' self-construal and learning productivity; and, 2) the levels of collaboration did not have a full mediating effect on technology's usability and learning productivity. The theoretical model was able to explain 76.1% of the variance of the distance learner's learning productivity collaborating on the CSCL platform.

Hence, the study proposed that the students' self-construal, students' prior CSCL experience and technology's usability will aid the students in achieving higher levels of collaboration, and in turn gain a favourable learning productivity. This study had looked within the collaboration among the distance learners by analyzing the levels of collaboration, and relating these levels of collaboration to the learning productivity of the distance learners. This study can contribute towards a more empirical understanding of learning productivity in an online collaborative platform, thus providing productive directions to the stakeholders in achieving the nation of lifelong learning and globalised online learning.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

MODEL PERAMAL PRODUKTIVITI PEMBELAJARAN DALAM PLATFORM PEMBELAJARAN KOLABORATIF BERBANTU KOMPUTER DI KALANGAN PELAJAR UNIVERSITI AWAM DI MALAYSIA

Oleh

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Jun 2015

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Kajian ini dijalankan untuk membangunkan model peramal produktiviti pembelajaran dalam platform pembelajaran kolaboratif berbantu komputer. Kajian ini berdasarkan Teori Jarak Transaksi *(Transactional Distance Theory)*, Teori Kehadiran Sosial *(Social Presence Theory)* dan Teori Pembelajaran Online berpandukan Sekolah Pemikiran Konstruktivis *(Online Learning Theory following the Constructivist School of Thought)*. Faktor yang diukur adalah pengenalan diri, pengalaman kolaborasi atas talian dan kebolehgunaan teknologi. Produktiviti pembelajaran diukur oleh prestasi pembelajaran, perolehan pembelajaran dan kepuasan dalam pembelajaran kepuasan pelajar. Tahap kerjasama diukur sebagai faktor perantara.

Dalam kajian ini, rekabentuk kajian yang digunakan ialah secara tinjauan deskriptif. Data dikumpulkan adalah daripada 103 pelajar jarak jauh, yang membentuk 24 kumpulan daripada 11 mata pelajaran yang berbeza. Dari analisis wacana, 12 kumpulan memperolehi tahap kerjasama yang tinggi, dimana mereka telah mengambil bahagian dalam perbincangan atas talian pada kadar yang sama sesama mereka. Analisis regresi pelbagai telah dijalankan untuk mengenal pasti peramal kumpulan yang yang empunyai tahap kerjasama yang tinggi (12 kumpulan, n = 43). Permodelan Persamaan Berstruktur telah digunakan untuk menguji fit keseluruhan bagi model yang dicadangkan (24 kumpulan, n = 103).

Kajian ini menghasilkan beberapa penemuan yang signifikan, antaranya model yang meramal produktiviti pembelajaran pelajar jarak jauh dalam platform pembelajaran kolaboratif berbantu komputer. Lima daripada tujuh hipotesis yang diutarakan telah disokong dimana laluannya terbukti signifikan. Laluan yang signifikan adalah: 1) pengenalan diri pelajar mempunyai kesan langsung terhadap tahap kerjasama pelajar jarak jauh (β = -0,743, p> .001); 2) pengalaman kolaborasi atas talian mempunyai

kesan langsung pada tahap kerjasama pelajar jarak jauh (β = -0,610, p <.001); 3) kebolehgunaan teknologi mempunyai kesan langsung pada tahap kerjasama pelajar jarak jauh (β = -0, 651, p <.001); 4) tahap kerjasama mempunyai kesan langsung ke atas produktiviti pembelajaran pelajar jarak jauh (β = .45, p <.001); 5) tahap kerjasama mempunyai kesan pengantara penuh pada pengalaman kolaborasi atas talian dan produktiviti pembelajaran (β = -0,642, p <.001). Anggaran seragam negatif adalah disebabkan oleh tahap tertinggi kerjasama diwakili dengan skor 1 dan sebaliknya.

Namun, terdapat dua hipotesis yang tidak disokong, iaitu: 1) tahap kerjasama tidak mempunyai kesan pengantara penuh pada pengenalan diri dan produktiviti pembelajaran; dan, 2) tahap kerjasama tidak mempunyai kesan pengantara penuh kepada kebolehgunaan teknologi dan produktiviti pembelajaran. Model teoritikal dapat menjelaskan 76.1% daripada varian dalam produktiviti pembelajaran pelajar jarak jauh yang berkolaborasi dalam platform pembelajaran kolaboratif berbantu komputer.

Oleh itu, kajian ini mencadangkan bahawa pengenalan diri pelajar, pengalaman kolaborasi atas talian dan kebolehgunaan teknologi akan membantu pelajar dalam mencapai tahap kerjasama yang lebih tinggi, dan seterusnya mendapatkan produktiviti pembelajaran yang menggalakkan. Kajian ini telah melihat ke dalam 'kotak hitam' kerjasama dengan menganalisis tahap kerjasama antara kumpulan, dan mengaitkan tahap kerjasama dengan produktiviti pembelajaran pelajar jarak jauh. Kajian ini boleh menyumbang ke arah pemahaman yang lebih empirikal tentang produktiviti pembelajaran pembelajaran dalam platform pembelajaran kolaboratif berbantu komputer., sekali gus menyediakan arah tuju yang produktif kepada pihak-pihak berkepentingan untuk mencapai pembelajaran sepanjang hayat dan pembelajaran atas talian global.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

AGFI	Adjusted Goodness of Fit Index
AIC	Akaike Information Criterion
BA	Bachelor of Arts *Bacelor Sastera*
BABM	Bachelor of Arts in Linguistic and Bahasa Melayu *Bacelor Sastera (Bahasa dan Linguistik Melayu)*
BCOMM	Bachelor in Communication *Bachelor Komunikasi*
BPTESL	Bachelor of Education in Teaching English as a Second Language *Bacelor Pendidikan (Pengajian Bahasa Inggeris sebagai Bahasa Kedua)*
BSHRD	Bachelor of Science in Human Resource Development *Bacelor Sains (Pembangunan Sumber Manusia)*
CD-ROM	Compact Disc- Read Only Memory
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CMS	Content Management Systems
CSCL	Computer-Supported Collaborative Learning
EDA	Exploratory Data Analysis
eHiED	eHigher Education
FWA	Flexible Work Arrangement
GFI	Goodness of Fit Index
HCI	Human Computer Interaction
HCSDLC	Human Computer System Development Life Cycle
HLI	Higher Learning Institution
HRDF	Human Resource Development Fund
ICT	Information and Communication Technology

IEEE	Institute of Electrical and Electronics Engineers
ISO	International Standard Organisation
IT	Information Technology
KMO	Keiser-Meyer-Olkin value
LCMS	Learning Content Management Systems
LMS	Learning Management Systems
LOLE	Lifelong Online Learning Environment
LTSA	Learning Technology Systems Architecture
MLE	Maximum Likelihood Estimation
MOHE	The Ministry of Higher Education
MRA	Multiple Regression Analysis
NFI	Normed Fit Index
NNFI	Non-normed Fit Index
OUM	Open University Malaysia
QCA	Quantitative Content Analysis
RMSEA	Root Mean Square Error of Approximation
SAD	System Analysis and Design
SCORM	Shareable Content Object Reference Model
SDLC	System Development Life Cycle
SEM	Structural Equation Modeling
SRMR	Standardized Root Mean Residual
TITAS	Islamic Civilization and Asian Civilisation *Tamadun Islam dan Asia Tenggara*
UiTM	Universiti Teknologi MARA
UKM	Universiti Kebangsaan Malaysia
UM	Universiti Malaya

UNITAR	Universiti Tun Abdul Razak
UPM	Universiti Putra Malaysia
UPM	University Putra Malaysia
UPMDL	Universiti Putra Malaysia Distance Learning
USM	Universiti Sains Malaysia
UTM	Universiti Teknologi Malaysia
UUM	Universiti Utara Malaysia
VIF	Variance Inflation Factor

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Malaysia is currently moving from a production-based economy to a knowledge-based economy, as outlined in Vision 2020. While information technology (IT) is the basic tool in achieving the knowledge-based economy, the main effort lies on the human capital. As such, the Malaysian government is currently upgrading the educational system in order to create a better, knowledge-based and skilled workforce. Among the initiatives to build the knowledge-based workforce include the use of IT as a tool for more pervasive teaching and learning, and to promote life-long learning system so that the workers would be able to upgrade their skills and knowledge.

As the human capital is the key element of the knowledge-based economy, a competent and highly skilled labour force must be developed. In recognising this, the Malaysian government has given considerable emphasis to the training and education of its people. This is clearly evidenced by large amount of allocations provided for the education and training sector in the country's annual budget, averaging about 25% per year (Ministry of Higher Education Malaysia, 2011).

Vision 2020, which represents the country's aspiration to become a fully developed nation by year 2020, requires a process of comprehensive transformation, particularly in the human capital development. Realising this, the Ministry of Higher Education Malaysia has identified 'Lifelong Learning' as the third pillar of the Human Capital Development, alongside with 'School System' and 'Tertiary Education' as the first and second pillar. Distance education and the concept of life-long learning were heavily promoted by the Malaysian government, where a tax relief of RM5,000 had been imposed to individual tax payers registering on various courses and study levels (Ministry of Finance, 2008). The effort was continued and reflected further in the 2014 Budget Speech that employers were encouraged to implement the Flexible Work Arrangement (FWA) to give flexibility in terms of duration, place and working hours at the workplace. On top of that, an amount of RM400 million was allocated by Human Resource Development Fund (HRDF) for registered companies to give opportunities to employees to enrol in upskilling and reskilling programmes (Ministry of Finance, 2014).

Institutions, too, play an important role whereby they need to ensure adequate supply of qualified and skilled staff in order to cater for the increase in demand for higher education. At the same time, working Malaysians should also be encouraged to acquire new knowledge and upgrade their skills to undertake the challenge of becoming an information rich society. The most sought after choice in improving the working adults' education levels is via distance learning courses.

In Malaysia, distance learning courses at tertiary level were first introduced by Universiti Sains Malaysia (USM) in 1971. The courses were originally offered via print-based materials in modular form and regular face-to-face tutorials. The first entirely virtual mode of education delivery was introduced by Universiti Tun Abdul Razak (UNITAR) in 1998, while the first truly open and distance learning university, Open University Malaysia (OUM), was established in 2000 (Ibrahim & Silong, 2000).

The increase of the demand in distance education was because distance learning provided an opportunity for adult learners to continue their studies (Alhabshi, 2002). This is beneficial for those who wish a fast and successful career without sacrificing their working commitments. The constraints faced by conventional teaching-learning approach in terms of inflexibility have made the students opt for distance learning instead, where they can learn at their own time, pace and place (Alhabshi, 2002; Ibrahim & Silong, 2000).

Table 1.1: Distance Education Centres in Public Universities

University	Centre
Universiti Putra Malaysia (UPM)	Centre for External Education
Universiti Malaya (UM)	Centre for Continuing Education
Universiti Sains Malaysia (USM)	School of Distance Education
Universiti Kebangsaan Malaysia (UKM)	Centre of Educational Extension
Universiti Teknologi Malaysia (UTM)	School of Professional and Continuing Education
Universiti Utara Malaysia (UUM)	Centre for Professional and Continuing Education
Universiti Teknologi MARA (UiTM)	Institute of Education Development

Public universities such as in Table 1.1 were also involved in lifelong learning programmes, using the designated centres to offer part-time extension and continuing education programmes.

In Malaysia, the number of students registered for distance education programmes increased from 757 in 1980 to 24,987 in 1997 (Economic Planning Unit, 2007). In the period of 2002-2013, the number of distance learners in public universities has increased to 131,000 (Ministry of Higher Education, 2015), which proved that a person's age, distance, work and family commitment no longer pose a barrier to knowledge. With 27% of distance learners from student population in public universities (Ministry of Higher Education, 2015), these universities are moving towards computer-supported learning platforms in distance education to disburse knowledge efficiently. The advantages of computer-supported learning platforms are there is greater flexibility in learning and the experience will prepare students for their future careers as corporations are increasingly making use of virtual teams (Lipnack & Stamps, 1997).

1.1.1 Online Collaborative Learning

The rapid growth of IT globally has also spurred the growth of online learning in higher education in Malaysia. The internet, together with the computer supported learning technologies, has changed the way students learn in e-learning. Even in Malaysia, the interaction within online learning no longer involves interaction between students and the learning content alone, but it has expanded to include communication and collaboration among groups of learners.

The advantages of collaborative learning in distance education had been proven by past researches. Klemm (2005) has indicated that although collaborative learning in online distance education is not a popular method of learning, it has been proven that online collaborative learning can be very effective, even more so than face-to-face collaborative learning. Lou, Bernard and Abrami (2006) further supported the claim when they had proven that greater effectiveness is achieved when students collaborate and learn from each other through discussions that challenge ideas and create multiple perspectives. So and Brush (2007) found that students who perceived high levels of collaborative learning tend to be more satisfied with their distance course. In short, various research has compared between collaborative and individual learning, and all had concluded that collaborative learning is more beneficial to students as it provides higher learning outcome (Manlove, Lazonder, & Jong, 2009; Harskamp & Ding, 2006), is better in generating

explanations (Wathen & Resnick, 1997), and encourages development of critical thinking (Gokhale, 1995).

However, the key issue that should be emphasized in collaborative discussion is whether it enhances learning. Most researches on collaboration had focused on individual learning rather than the synergy within the group itself. Dillenbourg and Schneider (1995) have argued that it is yet to be proven that the participation of learners within their group via different communication modes will enable participants to engage in a learning process. This is because in collaborative environments, circumstances that may reduce the benefits of collaboration may occur. Barcelo (2004) had given the example that when there is a passive student in a group, motivation for the whole group usually decreases as other group members may feel uncomfortable working with someone who refuses to contribute. Another example of collaborative discussion not benefitting the group is when one student begins to chat about other topics rather than the one that should be learnt (Barcelo, 2004). Hence, the collaboration among group members needs to be further investigated by looking at the collaboration process itself, formulating the levels of collaboration and identifying whether these levels of collaboration have any effect on the learning productivity.

1.1.2 Computer-Supported Collaborative Learning

The recent technology has enabled the distance learners not only to collaborate, but also to have easy accessibility of learning materials online. This scenario leads to the commencement of Computer-Supported Collaborative Learning (CSCL), a domain in the learning sciences focusing on how students may learn together with the aid of technology (Stahl, Koschmann, & Suthers, 2006). In Malaysia, the technology or mode of communication that could be incorporated into CSCL is vast, ranging from synchronous to asynchronous tools, and tools that provide unstructured and structured communications.

There have been a number of research focusing on the advantages and disadvantages of the synchronous and asynchronous tools, or comparing which is the better mode of communication (Bernard, Brauer, Abrami & Surkes, 2004; Carell & Menold, 2003; Abrami & Bures, 1996; Abrami et al., 1995). One thing in common is that all of these tools enable interactions between students. However, research has investigated the problems that distance learners face and found that there is a lack of interaction between distance learners and instructors and among distance learners themselves (Hara & Kling, 1999), a lack of prompt feedback (Dzakiria & Idrus, 2003) and no synchronous communication (So & Kim, 2005).

These problems are inline with the findings of an initial study by the researcher on undergraduate distance learners from Universiti Putra Malaysia (UPM). An initial survey was done to evaluate the readiness of UPM undergraduate distance learners on online learning and its associated technology. The major problems identified included the lack of interactions and miscommunications between the learners and administration, as well as the learners and the instructors and among the learners themselves. The findings on the same survey also revealed that although the learners know the advantages of synchronised communication and the benefits it offered to the distance learners in particular, majority of the students had opted synchronised communication as the least preferred method of discussion.

Research done by Lee, Magjuka, Liu and Bonk (2006) on the preference and effects of Chinowsky and Rojas' (2003) interactive technologies on collaborative learning revealed that groups actually preferred communication and cooperation technology (asynchronous tools) despite the advantages the collaboration technology (synchronous tools) offers. The researchers further suggested the need to change the focus to synchronous tools as it promotes online collaboration among group members in dispersed geographical areas (Lee et al., 2006).

The main rationale of the use of CSCL for distance learners is based on the grounds that students will have greater accessibility of communicating with each other during a course. However, being online alone doesn't mean that the students are productive, as Webb (1992) had argued, the favourable effects in terms of learning productivity of learners depended upon the elaborated explanation; whereas short and less elaborated messages from the explainer do not produce any effects. Although collaboration among group members will have an impact on the learning process and the learner's learning productivity, the issue is whether CSCL can act as a platform for distance learners collaborating online and result in favourable learning productivity.

1.1.3 CSCL and Learning Productivity

The learning productivity within the CSCL platform largely depends on the technologies used to support the platform and the characteristics of the learners (Hiltz, Rotter & Turoff, 2000). Specifically for CSCL within the distance learning environment, the goals of obtaining higher performance, gain and satisfaction were the commonly cited measures of learning productivity (Eom, Wen, & Ashill, 2006). Past researches indicate that group online collaboration leads to positive learning productivity due to effective design, instructor feedback and participation, participation patterns, the nature of assigned tasks or course, individual characteristics, group characteristics, mode of

communication and external environmental factors (Eom et al., 2006; LaPointe, 2003; Brandon & Hollingshead, 1999). The relationships between these factors appear to have an impact on online group collaboration and learning productivity in a distance education course (LaPointe, 2003).

For example, in terms of technology, different modes of communication lead to different levels of participation and interaction (Hathorn & Ingram, 2002). The main rationale of the use of CSCL for distance learners is based on the grounds that students will have greater accessibility of each other during a course. According to Nalley (1995), the fact that distance learners need to communicate with each other provides a reason for online collaboration tools because it is difficult for the students to meet face-to-face. However, the main issue is whether CSCL and its associated technologies can act as a platform for favourable learning productivity of distance learners. As Webb (1992) had argued, the effects in terms of learning productivity of learners depend not only on the technology, but also largely on the collaboration itself. He further explained that the favourable effects in terms of the learning productivity of learners depend on the elaborated explanation; whereas short and less elaborated messages from the explainer do not produce any effects.

In terms of online collaboration and interaction, there were mixed views of whether it enhances learning productivity. Several researches had actually identified disadvantages of group collaboration with regards to the learning productivity. For example, Dillenbourg (1999) claimed that group collaboration will cause extra cognitive load and information overload. Garrison, Anderson and Archer (2001) indicate that group collaboration via technology will lead more to surface learning rather than higher-order learning. Most researchers agree that group collaboration acts as a learning process and mediates the input factors, such as student, instructor, technology and course, to the learning productivity (Wan, Fang & Neufeld, 2007; Eom, Wen & Ashill, 2006; Benbunan-Fich, Hiltz & Harasim, 2005; LaPointe & Gunawardena, 2004).

Vician and Brown (2002) identified that individuals who are highly apprehensive about their written communication skills and computer skills avoid the use of technology for online learning, and hence, are unable to gain any learning benefits. The findings from Vician and Brown (2002) are in line with the initial study done by the researcher on the UPM undergraduate distance learners on their readiness for online learning and its associated technology. Among the relevant problems identified were the lack of computer skills, and hence, are unable to obtain any learning benefits. Most researchers agree that students with high levels of interaction will attain higher levels of achievement, while students who do not interact actively tend to become more distracted and less motivated (Zhang & Fulford, 1994; Webb, 1992).

The past researchers have identified that students' characteristics play a major role in their participation in online learning (Jung, Choi, Lim, & Leem, 2002; Howland & Moore, 2002; Kanuka, 2002; Oetzel, 2001, Hiltz et al., 2000; Rourke & Anderson, 2002). Self-construal or self image has been found to be a predictor of online group collaboration (Oetzel, 2001). In a traditional distance learning environment, being an independent learner is an important characteristic. However, the online learning environment of current distance learning, where technology and students interact, values an interdependent learner (Jung et al., 2002).

The overall online collaboration process that occurs in group learning in order to solve a task leads to the question in learning productivity. While technology provides the tools in enabling the collaboration among students, the reason in the productivity in learning was also due to the students' effort, the activities and the overall collaboration in learning (Benbunan-Fich, Hiltz & Harasim, 2005). Supported by the constructivist approach, the collaborative learning-to-learn offers increasing returns to scale in terms of the more the students put their effort in the learning process, the better productivity they will achieve (Miller, 2012).

Miller (2012) further added that the leap in the learning productivity can be achieved if the methods for understanding and acting on the potential for productivity improvements, both within and between the learning systems, are improved. As learning is an interactive and collaborative process, it is therefore important to identify the input factors and evaluate the online collaboration process that leads to the learning productivity.

The input factors, such as the students' characteristics and different modes and levels of collaboration, will lead to varying learning productivity in terms of learning gain and satisfaction (Guo, Klein, Ro, & Rossin, 2007). Technology, nature of groups and nature of tasks were also found to be interrelated (Kapur & Kinzer, 2007; McGrath, Arrow, & Berdahl, 2000). The online collaboration process, which can be evaluated in terms of the quantity and quality of the messages posted by students, may have a direct and different effect on the students' perceptions and satisfactions with their learning (Howland & Moore, 2002). Due to the above, there is a need to resolve and clarify these interrelationships and generate a learning productivity model that predicts the factors involved in the CSCL environment under the distance learning context.

1.2 Problem Statement

The overall learning cannot be separated from the process of context. Learning productivity can only be achieved when an interactive and collaborative process is happening to the learning context (Miller, 2012). This poses an issue in the distance learning environment, where the collaboration among the group members happens online, and in order for the interactive and collaborative process to occur, it highly depends on the technology that supports the collaboration and the characteristics of the distance learners themselves. Especially in Malaysia, the challenges arise in the distance education sector as the learners are left to study independently (Dzakiria, Kasim, Mohamed & Christopher, 2013) and the collaborative process is limited. Meanwhile, the institutions are aware of the advantages of the online collaborative learning for these distance learners, but they still opt for the traditional teaching - learning system based on self-instructional learning modules (Nawawi, Asmuni, & Romiszowski, 2003).

Studies were conducted at the local Research Universities and it was found that limited interaction and collaboration actually occurred within the university's learning management system (LMS) despite the availability of technological infrastructure (Kaur & Sidhu, 2010; Ramayah, 2010; Md. Khambari, Moses, & Wong, 2008; Tasir, Harun, & Noor, 2005). Kaur and Sidhu (2010) highlighted the lack of prompt replies in an online environment, whereas Md Khambari et al. (2008) found that the university's LMS was used mainly to download and upload the learning materials. Tasir et al. (2005) claimed that the learning materials in the LMS were fully controlled by the lecturers and Ramayah (2010) indicated that the interactive features in the LMS were not fully taken advantage of. These lead to the problems in terms of lacking interactions, and the feeling of loneliness and apprehension among the distance learners (Ellis & Anderson, 2011; Dzakiria & Idrus, 2003).

All of these current situations contradicted with the Ministry of Higher Education's aspirations to focus on outcomes over inputs and to actively pursue technologies that address the students' needs in terms of lifelong learning and enable greater learning experience as stated in the Malaysian Education Blueprint 2015-2025 (Ministry of Higher Education, 2015). This phenomenon was mainly because the lack of framework that highlighted the factors that contribute to the greater learning productivity of these distance learners collaborating in an online platform. This learning productivity framework should include the need to evaluate the tools that allow synchronous student communication, which will lead to issues and queries to be resolved immediately and reduces limitations in online collaborative learning.

In terms of technology, most online learning frameworks generated address a specific learning functionality and in most of the cases, they were not developed to link with other online learning tools or environments (Homan & Macpherson, 2005; Siqueira, Braz & Melo, 2004; Akar, Ozturk, Tuncer, & Wiethoff, 2004). As technology was one of the inputs for collaborative learning, there is also a need to evaluate how technology may play a part in the learning productivity of online learning. Furthermore, most existing online learning frameworks did not take into consideration the network environment of online learning that caused the students to interact with each other (Jung et al., 2002). Jung et al. (2002) also highlighted the problems in the current online learning framework which include limitations in active learning and limitations in collaborative learning. Therefore, there is a need to provide a model that takes into consideration the collaborative process that happens in the CSCL environment in order to predict learning productivity.

A preliminary survey was conducted on UPM undergraduate distance learners, where the learning activities consisted of face-to-face meetings in terms of lectures and tutorials, video conferencing sessions (collaboration technology) and viewing the recorded video conferencing sessions via web asynchronously. The results of survey indicated that the preference in learning activity of UPM undergraduate distance learners were similar with the research done by Lee at al. (2006) when the majority of the students had opted collaboration technology as the least preferred method of learning and discussion. Further analysis on the results revealed that students were facing communication problems, either with lecturers, tutors, administrative staff or among themselves. In the current situation of UPM distance learners, online collaboration is offered via video conferencing alone. This lack of venue for collaboration may have an impact of their level of collaboration and learning productivity.

The problems could be summarised as the distance learners were left to study independently despite the changing collaborative nature of online learning, the problems faced by the distance learners as a result of independent learning, the university's current LMS platform were not utilised and contradiction of the current situation with the nation's aspirations in achieving greater output in lifelong learning. Specifically in UPM, the current technological infrastructure provides limited venue for collaborative learning. The gap of studies in literature includes limited focus on the exploration of the collaboration process within the online learning framework and the ambiguity of the factors affecting the distance learners learning productivity in an online collaborative learning environment.

Hence, the collaboration among the distance learners needs to be evaluated, while the factors to predict the learning productivity of the distance learners need to be identified.

1.3 Research Objectives

This research aims to develop a predictive model for the learning productivity of distance learners in a CSCL environment. Greater learning outcome in an online collaborative environment depends largely on the technology that supports it, the distance learners themselves and the interaction between them. Hence, there is a need to understand the students' characteristics, technology's usability and the levels of collaboration among these distance learners.

In more specific, the research objectives of this study are as follows:

1. To identify the level of collaboration among distance learners in using collaboration technology for accomplishing tasks.

2. To examine differences between the factors that predict the learning productivity of all groups and the factors that predict the learning productivity of high levels of collaboration groups.

3. To identify the direct effect of students' self-construal, prior CSCL experience and technology's usability to the levels of collaboration of distance learners.

4. To examine the mediating effect of levels of collaboration on the students' self-construal, prior CSCL experience, technology's usability and the learning productivity.

5. To develop a predictive model of a learning productivity of distance learners.

1.4 Research Questions

The research questions are formulated as follows:

1. What are the levels of collaboration among distance learners in using the collaboration technology for accomplishing tasks?

2. What are the factors that influence the learning productivity of highly collaborated groups?

3. What are the factors that influence the learning productivity of all groups?

4. What are the differences between the factors that predict the learning productivity of highly collaborated groups and the factors that predict the learning productivity of all groups?

5. Does the student's self-construal have any direct effect on the levels of collaboration?

6. Does the student's prior CSCL experience have any direct effect the levels of collaboration?

7. Does the technology used have any direct effect on the levels of collaboration?

8. Does the level of collaboration mediate the effects of students' self-construal on the learning productivity of distance learners?

9. Does the level of collaboration mediate the effects of prior CSCL experience on the learning productivity of distance learners?

10. Does the level of collaboration mediate the effects of technology's usability on the learning productivity of distance learners?

11. What is the predictive model for the learning productivity of the distance learners in the CSCL platform?

1.5 Hypotheses

The research hypotheses are put forward based on the study's research objectives and also the literature review.

H_{a1}: Students' self-construal has a significant effect on the levels of collaboration of distance learners.

H_{a2}: Prior CSCL experience has a significant effect on the levels of collaboration of distance learners.

H_{a3}: Technology's usability has a significant effect on the levels of collaboration of distance learners.

H_{a4}: Levels of collaboration have a significant effect on the learning productivity of distance learners.

H_{a5}: Levels of collaboration have a full mediating effect on students' self-construal and learning productivity.

H_{a6}: Levels of collaboration have a full mediating effect on prior CSCL experience and learning productivity.

H_{a7}: Levels of collaboration have a full mediating effect on technology's usability and learning productivity.

1.6 Significance of Study

The study predicting the factors that influence the distance learners' learning productivity would add to the growing body of knowledge as it focuses on the conditions that are crucial to the success of the overall online learning environment, which are the technology and the collaboration among learners. The predictive model will guide the development of an online learning system as it highlights the factors affecting conditions for online learning. Meanwhile, the experience of collaborating online will provide the learners the technical knowledge and experience of working with virtual teams, which is highly demanded by employers (Kirschner, Martens, & Strijbos, 2004).

The study will be of great interest to the Ministry of Higher Education in its mission to cultivate a nation of lifelong learners. The study of learning productivity is vital in order to understand the inputs needed in order for distance learners to embrace lifelong learning and gain more on learning per student effort. Lifelong learning enables Malaysians not only to enrich themselves but also to develop quality knowledge workers. Moreover, the Ministry of Higher Education aims for globalised online learning via blended learning models with the support of synchronous and asynchronous technologies, as stated in the Malaysian Education Blueprint 2015-2025 (Ministry of Higher Education, 2015).

Therefore, this work which studies on the factors predicting distance learners' learning productivity will provide a framework that can be used to evaluate their characteristics. This is necessary considering the fact that physical output is no longer the main factor of learning. Instead, the factor lies in terms of personal knowledge that is acquired through interaction and reflection. Since learning happens outside the boundary of formal education which involves the usage of technology, the gains in the learning productivity may also be influenced by the adoption of the technology used. Therefore, the framework developed in this study will guide the identification of suitable technologies, as well as the processes and the responsibilities by the parties involved for the learners to gain greater learning productivity in the online environment.

Currently, almost all private and public universities in Malaysia have developed their own e-learning portal. However, students seldom collaborated within the environment (Kaur & Sidhu, 2010; Ramayah, 2010; Md. Khambari et al., 2008; Tasir et al., 2005). This is mainly due to the fact that the ubiquitous

environment of e-learning was not being taken full advantage of (Ju, Kim, Kim, & Kang, 2006). Ju et al. (2006) also highlighted that among the problems in the current e-learning framework are limitations in active and collaborative learning. Therefore, this study will provide a predictive model on learning productivity which will guide the universities in promoting collaboration among their students. Moreover, according to Siqueira et al. (2004), there is yet a general model that will guide the development of collaboration technologies within e-learning, which is another reason why this study needs to be carried out at this point in time.

This study will also predict the significant factors in measuring learning productivity and level of collaboration with respect to students' characteristics and skills, collaboration effort by students and technology characteristics. Achieving the objective may help institutions and instructors to tailor their infrastructures and learning context to grasp the advantages of collaborative learning. It will also provide some indication of the technology preferred by students to accomplish their tasks. The findings of this study are vital as most researchers tested the variables in isolation (Paulus, 2007; Lin & Overbaugh, 2007; Lee et al., 2006; McGrath & Berdahl, 1998). There is yet a theory of distance education that examines the level of collaboration with respect to the selected variables, and relates it to the learning productivity of the distance learners. Thus, the findings of this study hopefully will fill that void.

This study will give insights into the factors that have caused one of the common problems of distance learners, which is, the collaboration with each other. The finding will be of great interest to the institutions offering distance learning courses and higher education professionals responsible for the provision and design of distance learning programmes. The instructional designers and developers may benefit from greater understanding of collaboration technology and its effect on learning productivity. The instructors may obtain pedagogical guidance in formulating strategies for online learning collaboration. Finally, the findings from this study will be significant for researchers who are interested with the use of technology for online learning and collaboration.

1.7 Limitations of the Study

The respondents of this study are considered representatives only if they are distance learners who are undertaking courses with group work. Cluster sampling was performed on the distance learners registered on the CSCL platform. Accordingly, the generalisation of this study is limited to the groups having the same characteristics as those of the respondents of this research.

Although there were many forms of interactions within distance learning, this study focused only on student-student interaction and student-interface interaction. This was because the student's control over the online learning process is mainly concerned with the degree the student can guide her learning experiences and it relates to the online communities and technologies (Rahimi, Van den Berg, & Veen, 2014). In particular, this study examined the interaction that occurred via collaboration technology, which was saved in the system's archive log. The archive log was examined to determine the levels of collaboration within and among groups. Any conversation that occurred via other communication modes was not included in this study.

Nonetheless, this study did not control the students' characteristics, the assigned tasks or the students' computer skills. The students were asked to self-report on their satisfaction of collaboration technology and the learning productivity achieved after using the said technology. Hence, this study was limited to the exploration of the distance learners' perception of the said factors. However, the researcher ensured that the conditions to which the self-reflected information was likely to be valid were made available such as: (1) the information requested was known to the respondents; (2) the questionnaires were phrased clearly; (3) the questions referred to recent activities; (4) the respondents think the question merit a serious and thoughtful response; and (5) answering the questions will not harm the respondents or encourage the respondents to respond in socially undesirable ways.

Another limitation was in terms of the method used to analyse the conversation logs, which was the quantitative discourse analysis. The learners' conversations were coded quantitatively according to predetermined rules. Hence, some interpretations may be lost as the conversation was not analysed beyond what was written in the logs.

1.8 Definitions of Terms

The operational terms used in this study were defined as follows:

Learning Productivity

For a CSCL system, favourable learning productivity depends on adequate levels of technological infrastructure, use and experience with the system, and satisfaction with the system (Hiltz et al., 2000). Specifically for CSCL within the distance learning environment, the goals of learning gain and learning satisfaction were the commonly cited measures of learning productivity (Eom et al., 2006). For the purpose of this study, learning productivity is defined as

the learning output by producing greater gains, greater satisfaction and increased performance per student effort.

Learning Gain

Learning gain is defined as the perceived benefits that the students get in terms of their intellectual skills, personal and social development and general education (Hu & Kuh, 2003). In this study, learning gain refers to the degree of the distance learners' perceptive achievements and the feeling that they have accomplished, either via group effort or via individual effort.

Learning Satisfaction

Learning satisfaction is a positive or negative affective response to the learning environment and an important consideration for future participation in learning (Oetzel, 2001; Gunawardena & Zittle, 1997). In this study, learning satisfaction refers to the degree to which the learners react to the affective response either to the learning environment or to the learning experience.

Learning Performance

Actual marks obtained in order to measure the students' performance were recommended in order to obtain a more realistic understanding on the students' overall learning productivity (Guo et al., 2007; Hassmén, Sams, & Hunt, 1996). In this study, the learning performance is the actual marks awarded by the lecturer to each group based on their work.

Computer-Supported Collaborative Learning (CSCL)

In educational setting, CSCL environment encompasses several characteristics, such as being able to give support in order for students to understand new information, relate it with the previous information that they already had, compare and identify different interpretation of the same information (Wan & Johnson, 1994), encourage the students to collaborate online (Rammamurthy, Wilhelmson, Pea, Gomez, & Edelson, 1995) and support a range of communication channels (Barcelo, 2004). In this study, CSCL is defined as an online platform which has the necessary support in terms of communication media for the distance learners to collaborate with each other.

Collaboration Technology

The technologies within CSCL, regardless of being synchronous or asynchronous, are capable to provide the interactions required by students to collaborate (Chinowsky & Rojas, 2003). In this study, the term collaboration technology is defined as synchronised tools such as real-time chat or web

conferencing which provide real-time communication and experiences. The terms collaboration technology and synchronised tools are used interchangeably in the study.

Students' Characteristics: Self-construal

Students differ in their skills, abilities, knowledge, experiences and their motivations, all of which influence their levels of collaboration and learning productivity (LaPointe & Gunawardena, 2004). A student's personality traits are among the influential factors affecting active participation in online interaction (Jung et al., 2002). In this study, the definition of self-construal is the perceived self-image of the distance learners. This definition is used for both independent and interdependent self-construal.

Students' Characteristics: Prior CSCL Experience

Prior CSCL experience is defined as the computer experience and frequency of computer use online (Swan et al., 2000). The students who are more experienced with the technology will understand how technology supports the overall learning processes, and will be more likely to be satisfied and succeed with any online collaboration (Lim, 2001; Swan et al., 2000; Zhang & Espinoza, 1998). Prior CSCL experience in this study is defined as the degree of familiarity and ability to process information online, which leads to knowing when and how to contribute to the online discussion.

Technology's Usability

Usability is widely defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (Te'eni, Carey, & Zhang, 2007). This study adopts the three main characteristics of usability and it is defined as the degree to which the technology is used by the distance learners to perform online collaboration with effectiveness, efficiency and satisfaction.

Levels of Collaboration

In order to evaluate the levels of collaboration, researchers had included Positive Interdependence, Face-to-Face Interaction, Individual Accountability, Interpersonal and Small Group Skills (Johnson & Johnson, 1991), Participation, Social Grounding, Active Learning, Performance Analysis and Group Processing and Promotive Interaction (Soller & Lesgold, 2007). The level of collaboration in this study is defined as the degree to which the students interact almost equally with their group members and create knowledge during the interaction.

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