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Culturally-Enhanced Computer Game: The Impact on Educational Effectiveness

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Abstract: Fascination of young generation towards computer game had sparked the interest of academicians to use computer game to support education. The tremendous time spent and constant interactions with computer game had literally changed the young generation's learning expectations, preferences and needs. However, researchers found that learner's culture also has influence on learning expectations, preferences and needs. Literature shows that studies of culture in relation to computer game or known as culturally-enhanced serious game is still lacking and limited. As to date, only a few culturally-enhanced serious game existed in the literature, therefore the impact of culturally-enhanced serious game on educational effectiveness is still scare. Thus, this study aims to report on the educational effectiveness of a culturally-enhanced serious game. This researcher employed true-experimental design method with a control group. A total of 91 students of Universiti Teknologi petronas participated in this research work. One-way ANOVA was performed to evaluate the hypotheses. The outcome of this research work shows that participants who played culturally-enhanced serious game had better performance as compared to participants in other groups, thus indicates that culturally-enhanced serious game is an effective learning tool for young learners.

Key words: Computer game, culturally-enhanced computer game, culture, ANOVA, effective learning tool

INTRODUCTION

Electronic games such as video games or computer games have become a new leisure activity not only for ardent gamers but also for other people. Increasingly, computer games have become a family hobby where people play together socially either online or in real spaces (Karl and Scott, 2010; Prensky, 2001) reported that on average a higher education student spent more time on computer games as compared to reading. Recent study conducted by Entertainment Software Association (ESA) showed that on average approximately 10,000 h were spent on playing computer games by Americans by the time they reach 21 year old. Similar trend was also found among young Malaysians where 100% of first year and second year students had experience playing computer games (Ibrahim *et al*., 2012). Additionally, a study conducted by Pawanteh *et al*. (2009) revealed that young Malaysians spent 26 h per week on computer activities such as computer games. Considering how computer games have received considerable attention from people world wide, the academic education research community nowadays has begun to pay significant attention to the ways in which computer games might support learning in order to meet the young learner's learning needs, preferences and expectations (Perrotta *et al*., 2013; Wouters *et al*., 2009).

Many researchers described young learners as generation who anticipates immediate responses, active involvement in learning process, learning-by doing, interactivity, relevancy between acquired knowledge with their context, in additional to fun and entertaining learning environment (Conrad, 2010; Deshpande and Huang, 2011; Prensky, 2001). These expectations and preferences were differed to the previous generation of learners due to constant interactions and astounding time spent on computer games (Oblinger and Oblinger, 2008; Martens *et al*., 2008). However, researchers also highlighted that learning needs, preferences and expectations were also attributed to the culture of a particular learner (Economides, 2008; Henderson, 2007; Littlewood, 2000, 2001; McAnany, 2009; McLoughlin and Oliver, 2000; Mohammed and Mohan, 2010; Parrish and Vanberschot, 2010; Subramony, 2011; Swierczek and Bechter, 2010; Young, 2008a, b). For example, Eastern learners were prone to teacher-centered learning style in contrast to Western learners who expect constructivist learning style in class, thus Eastern learners do not

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favored social constructivist e-Learning tool (Littlewood, 2000, 2001). Therefore, take into account the learner's culture could assist in improving learning (Brown, 2007; Hardaker and Sabki, 2007), in contrast failure to address this aspect could hinder the learning process. Despite the compelling connections between culture and learning, Mohammed and Mohan (2011) and Young (2008a, b) highlighted that the study on this aspect in relation to computer game is still limited. Thus, the aim of this study is to report on the educational effectiveness of a culturally-enhanced computer game.

Literature review

Computer game : There is no shared definition of the term 'games' in literatures. Dempsey described computer games as collections of action between one or more individuals (called players) in an artificial setting where players contest (even with one-self), abide to particular instructions, collect rewards or receive penalties (as the outcomes of their actions) in their quest to achieve pre-defined goals. Therefore, in general computer games have story or goals, game mechanics, rules, conflict, interactivity, graphical representation and a sense of challenge or competition.

Computer games offer several advantages such as provide safe and non-risky environment called 'microworld' for learners to apply their knowledge allow learners to actively participate and engage by becoming part of the game scenario and motivate learners (Guimaraes *et al*., 2012; Thompson and Irvine, 2011). Effectively exploit these advantages could make computer game an effective tool for teaching and learning.

Fascination towards computer game was also found among Malaysia's higher education students, where 100% of first year and second year students of a local university had experience playing computer games (Ibrahim *et al*., 2012). Based on these findings, it clearly shows that computer games received positive acceptance among learners in higher education institutions. In additional, a study conducted by Lampson (2004) revealed that young learners in Malaysia spent 26 h per week on computer activities such as computer games. Similar perception was also reflected in Ibrahim *et al*. (2012) where 59% of first, second and third year students of a local university had experienced playing computer games for >5 year. Furthermore, in the same study, it was also found that 66% of them play games few times per day. These findings suggested that computer games activity is integral to the Malaysian young learner's life. Consequently, this astounding amount of time spent on computer games influenced the perception and expectations of higher education learners towards learning (Oblinger and Oblinger, 2008; Martens *et al*., 2008). Similar conclusion were also made by other researchers in educational domain such as Hainey (2010), Papastergiou (2009) and Virvou and Katsionis, (2008). Many researchers described this new generation of learners who anticipate immediate responses, active involvement in learning process, learning-by doing, interactivity, relevancy between acquired knowledge with their context, in additional to fun and entertaining learning environment (Conrad, 2010; Deshpande and Huang, 2011; Prensky, 2009). Thus researchers such as Chen and Yang (2011), Karl and Scott (2010) and Kron *et al*. (2010) advocated that computer games fulfill these anticipations, learning needs, expectations and preferences of the young learners. This study found that game activities were integral to the life of Malaysians higher education learners. Regardless of gender, on average they dedicated more than an hour per week just to play games. Thus, this study attempted to leverage the technology (in this case is serious game) which currently adores by higher education learners for supporting their learning needs.

Culture: As mentioned earlier, the learning needs and expectations were also attributed to the culture of a particular learner (Economides, 2008; Henderson, 2007; McAnany, 2009; McLoughlin, 2008; Mohammed and Mohan, 2010; Parrish and Vanberschot, 2010; Subramony, 2011; Swierczek and Bechter, 2010; Young, 2008). Culture refers to "shared motives, values, beliefs, identities and interpretations or meanings of significant events that result from common experiences of members of collectives that are transmitted across generations" (House *et al*., 2004). Hofstede further added that culture is shared pattern of the mind that differentiates the members of a group from another (Hofstede and Hofstede, 2005). Hence, a collective or a society will have similar and distinct behavior patterns, preferences, expectations and tendencies which distinguish them from other collective or society. For example, Koreans prefer to have very structured websites with lots of animations, hyperlinks and colors whereas Swedish found these features as very disturbing and irritating (Reinecke, 2010).

Researchers highlighted that there exist relationship between culture and learning (Economides, 2008; Mohammed and Mohan, 2010; Young, 2008a, b). Addressing these aspects could influenced the learners motivation towards learning contents as well as assist learners to 'see' the relevancy of the learning contents to learner's culture and environment. Despite the compelling connection between culture and learning, studies in this area is still lacking particularly related to computer games

(Economides, 2008; Mohammed and Mohan, 2010; Young, 2008a, b). Currently, only a few computer games were found in literature which consider learner's culture in its game design and interfaces or simply called as culturally enhanced computer game. For example, Smoke? (Khaled *et al*., 2009), Trinbago Adventures of L Macawell (TALM) and Caribbean Conquest (Mohammed and Mohan, 2010). With limited number of existing culturally-enhanced computer games, its impact on educational effectiveness is scarce and limited.

Computer security education: Pfleeger and Pfleeger, (2006) referred computer security as an effort or action to safeguard the computing systems components in terms of its confidentiality, integrity and availability. Meanwhile, Lampson (2004) defined computer security in a broader term which is safeguarding computer systems against any malicious events. In essence, the main aim of computer security is to formulate methods to avoid any system flaws from being abused (Du and Narayanan, 2006; Monk, *et al*., 2010).

Association of Computing Machinery (ACM) and Association of Information Systems (AIS) highlighted that understanding, managing and controlling Information Technology risks is one of capabilities that should be possessed by graduates upon graduation. In response to this, many universities have incorporated computer and information security courses into their undergraduate and graduate curricula (Du and Narayanan, 2006; Taylor and Azadegan, 2008; Turner *et al*., 2011). Although, ACM-IS highlighted that computer security education was very important, its delivery methods do not suit to the young learners. For example, in order to discover the real consequences of malicious attack in an organization and fully grasp the concepts, learners may prefer practical and hands-on. However, to really injecting virus on the university's network, it will be too risky and illegal. As a consequent, lecture-based method was used where learners learn the concepts without any chances on the application of that knowledge. This limitation could impede the learning process especially to young learners who anticipate different learning approach. Thus, this study believes that using technology (in this case is serious game) which adores by young generation nowadays could help to address the limitation of teaching and learning computer security education.

MATERIALS AND METHODS

This study compared two computer games on computer security concepts. The first computer game is called CyberCIEGE and the second is called my-CEN. These computer games were identical in terms of embedded learning objectives and learning content, however differed only in that CyberCIEGE was constructed based on the culture of United States, whereas my-CEN was developed based on the Malaysian culture. The next study will explain each computer game in detail.

Cyber CIEGE computer game: CyberCIEGE was developed by Rivermind Inc. in collaboration with educators and developers from United States (Thompson and Irvine, 2011). Researchers such as McLoughlin and Oliver (2000), Mohammed and Mohan (2011) highlighted that the selection of game interfaces, design strategies and content materials were heavily influenced by the culture of the developers. Hence, it could be inferred that the game strategies and interfaces of CyberCIEGE were designed and constructed based on the Western culture.

My-CEN computer game: As mentioned earlier, My-CEN was a computer game that has identical learning objectives and learning content as CyberCIEGE. The authors customized my-CEN computer game by using Scenario Development Tool (SDT) provided by Rivermind Inc. my-CEN computer game portrayed Malaysian culture markers in the game interfaces and its design strategies. Authors used Hofstede's Value Survey Module (VSM) and Game Design Model (GADEM) (Mazeyanti, 2013) as guidelines in the design and development process. The customization of my-CEN serious game was not limited to game interfaces only but also covers its design strategies such as hints, feedbacks and assessments. For example, Malaysian learners expect positive and encouraging responses from instructors during the learning process (Benson, 2007; Littlewood, 2001; Neo and Neo, 2009; Neo, 2005; Smith, 2003). Applying this practice in the computer game context leads to the use of constructive, inspiring words in game dialogues and messages, instead of strict responses. Therefore, my-CEN computer game is considered as a culturally enhanced computer game.

Participants: This study used true-experimental design and involved 91 participants from first year students of Computer and Information Sciences Dept. of Universiti Teknologi PETRONAS. The participants of this study are Malaysian students and comprises of varieties of ethnics. This study only selected Malaysian students since the developed serious game (my-CEN) was constructed to portray the Malaysian culture. Participants were randomly divided into 3 groups: Control (X_1), Experimental 1(X_2) and Experimental 2(X_3). The participants in X_2 group played CyberCIEGE meanwhile X_3 played my-CEN computer

game. All participants were required to take pre-test prior to the game play activity and later took post-test after 3 weeks of playing the computer games. The questions of pre-test and post-test were related to computer security concepts. The pre- and post-test questions were designed to assess the acquisition of procedural knowledge on computer security principles and malicious threats to organization. The questions were designed based on one of the learning outcomes from Computer Security course which is to instill fundamental concepts of computer security as well as analyse and propose suitable security mechanism to a real computer security problem. Based on the literature review, the following hypotheses were constructed

- H_{01}: There is no significant difference between pre-test mean scores of X_1-X_3 group
- H_{02}: There is no significant differene between the post test mean scores of X_1-X_3 group
- H_{03}: There is no significant difference on acquisition of knowledge between X_1-X_3 group

All hypotheses were analysed by using one-way ANOVA. One-way ANOVA test is appropriate to test the hypotheses when there are more than two groups (Sekaran, 2006). Furthermore, ANOVA was used since this research work met with ANOVA assumptions. For example, the data is considered as normally distributed due the sample size was >30 (Sekaran, 2006), samples were randomly selected and this research work compares >2 groups. Therefore, the usage of one-way ANOVA was justified.

RESULTS AND DISCUSSION

Table 1 depicts the participant's ethnicity. About 84.00% (n = 76) of participants were Malay, 10.00% (n = 9) were Chinese and the remaining 6.00 (n = 6) were Indian. This result indicates that participants came from varieties of ethnics.

The pre-test evaluation: In this study, hypothesis evaluation was performed to the collected data. To test the hypotheses, one-way ANOVA was performed to analyse the significant difference of all groups (Table 2).

Table 1: Participants ethnicity

Information	Frequency	Percentage (%)
Ethnicity		
Malay	76	84.00
Chinese	9	10.00
Indian	6	6.00

show the one-way ANOVA result for $H_0$1. Findings reveal that F (2,88) = 1.127, p= 0.329. The p-value is greater than α value of 0.05. This result indicates that, there is no significant difference between the pre-test mean marks of participants in X_1-X_3 which means participants prior knowledge was not significantly differed in all groups. Therefore, the null hypothesis ($H_0$1) was supported.

The finding suggests that the same level of knowledge was acquired by the participants in all groups on the tested topic, thus satisfied the aim of conducting pre-test where participants in all groups should have similar level of knowledge on the tested topic.

The post-test evaluation: To assess $H_0$2, a one-way ANOVA was performed to determine if the post-test score was significantly differed between X_1, X_2 and X_3. Similar to pre-test evaluation, one-way ANOVA was the most suitable to test the hypothesis since the study was comparing more than two groups. Table 3 depicts the one-way ANOVA result for $H_0$2.

Statistically significant different between the post test scores were found F (2,88) = 4.119, p = 0.020. The F value is significance at 0.020 level. This implies that $H_0$2 was rejected. That is, there were significant differences on the post-test marks in the three groups (X_1, X_2 and X_3). This finding suggests that the level of knowledge across participants in X_1, X_2 and X_3 was differed after receiving the treatment.

The knowledge increment evaluation: To discover whether the participant's improvement was significant, hypothesis evaluation was performed. A null hypothesis ($H_0$3) was created and stated below. To assess the knowledge improvement, pre-test marks were subtracted from the post-test marks and a one-way ANOVA using α = 0.05 was performed to test $H_0$3. Table 4 shows the

Table 2: One-way ANOVA result for H_{01}

Post_test	Sum of squares	df	Mean square	F-value	Sig.
Between groups	17.305	2	8.653	1.127	0.329
Within groups	675.882	88	7.680		
Total	693.187	90			

Table 3: The one-way ANOVA result for H_{02}

Post_test	Sum of squares	df	Mean square	F-value	Sig.
Between groups	103.986	2	51.993	4.119	0.020
Within groups	1110.915	88	12.624		
Total	1214.901	90			

Table 4: The one-way ANOVA result for H_{03}

Post_test	Sum of squares	df	Mean square	F-value	Sig.
Between groups	162.976	2	81.488	4.911	0.010
Within groups	1460.167	88	16.593		
Total	1623.143	90			

Table 5: The Scheffe's post-hoc test for total increment

(I) participants	(J) participants	Mean difference (I-J)	SE	Sig.
X1	X2	0.23333	1.05175	0.976
	X3	-2.70000*	1.04324	0.040
X2	X1	-0.23333	1.05175	0.976
	X3	-2.93333*	1.04324	0.023

Table 6: The Scheffe's post-Hoc test for total increment

	Subset for alpha = 0.05	
Participants (N)	1	2
X2 (30)	2.0667	
X1 (30)	2.3000	
X3 (31)		5.0000

X1 = control; X2 = CyberCIEGE; X3 = My-CEN computer game

one-way ANOVA result for H_{03}. The ANOVA analysis reveals that significant statistical difference was found in improvement score between X_1-X_3 ($F(2, 88) = 4.866$, ($p = 0.010$)). The F value is significant at the 0.010 level. This implies that H_{03} was rejected. Therefore, this result indicates that all groups showed significant improvement regardless of the type of intervention received by them.

In order to identify which group performs better as well as to identify which intervention was the most effective, a Scheffe's post-hoc test was conducted. Scheffe's post-hoc test was appropriate for determining the significant differences in the means after the ANOVA procedure has been performed (Sekaran, 2006) as well as due to unequal sample size of each group. Table 5 and 6 depicts the Scheffe's post-hoc result for knowledge increment for X_1-X_3.

From Table 4, it shows that the means of the three groups (X_1-X_3) differ significantly (at $p<0.05$ level) from each other. The mean for X_3 ($M = 5.00$) is significantly higher than X_1 ($M = 2.30$). Meanwhile, the X_1 mean value is also significantly higher than X_2 ($M = 2.06$). These results suggest that participants who played my-CEN computer game (X_3) demonstrated significantly higher improvement than those who played CyberCIEGE computer game (X_2) and control group (X_1). In other words, it was learnt that participants in X_3 scored better thus illustrated better performance after playing my-CEN computer game as compared to playing CyberCIEGE computer game (X_2) and control group (X_1). Hence, this result suggests that learning from culturally-enhanced computer game was found to be the most effective intervention among the participants. This is consistent with findings reported by Johnson and Wu (2008), Khaled *et al.* (2009), Mohammed and Mohan (2009).

Interestingly, participants from control group (X_1) performed significantly higher than participants in X_2. As mentioned earlier, participants in X_2 played computer game which portrayed culture characteristics which were dissimilar to the learner's culture, meanwhile X_1 received learning session from instructor who came from similar culture, (i.e., Malaysian). This finding suggests that learning from environment that is culturally similar to the learners may influence the performance of the learners due to familiar and matched cultural context. This is consistent with recommendation made by scholars who highlighted on the undeniable connection between learning and culture. Additionally, the finding also suggests that learners in X_3 exhibited significantly higher performance as compared to the other groups. This result may be attributed to the existence of familiar cultural characteristics in my-CEN computer game. As mentioned earlier, the design and customization of my-CEN computer game was made based on the learner's cultural needs and expectations. Therefore, these cultural elements creates familiar and relaxing environment hence encourage learners to demonstrate better performance. This finding is consistent with suggestion made by scholars who emphasize on the importance of customizing learning material to match the local needs. Therefore, customizing computer game that matched to the local style and local anticipation may increase the effectiveness of the computer game.

Additionally, the existence of local examples and metaphors in my-CEN computer game encourage assist learners in connecting the acquired knowledge with the real-world situation. This result is consistent with studies done by Economides (2008), Mohammed and Mohan (2010), Young (2008) who emphasize on the importance of utilizing local examples and metaphors to enforce learning experience.

CONCLUSION

To measure the effectiveness of the developed culturally-enhanced serious game, an effectiveness test was conducted where the learner's knowledge change was assessed. The effectiveness test used true experimental research design and involved 91 participants from Computer and Information Sciences Dept UTP. To assess the knowledge change, pre and post-test were administered to the learners. The pre and post-test questions were designed based on a topic in computer security education which is "malicious code attacks". Hypotheses were constructed to assess the knowledge change among the learners. One-way ANOVA and Scheffe's post-hoc statistical tests were performed to the collected data.

This study concludes that, findings from the hypotheses evaluation suggested that all hypotheses were substantiated except for $H_0$1. The results illustrate

that participant who played culturally-enhanced computer game performed better as compared to participants in the other groups. This result may be contributed to the existence of familiar cultural elements in my-CEN computer game. Thus, these cultural elements provide familiar and relaxing context hence demonstrated better performance. Additionally, the existence of familiar cultural elements in my-CEN computer game assists learners in connecting the acquired knowledge with the real-world condition. The results suggest that there is significant knowledge change between learners playing my-CEN serious game, learners playing contemporary serious game and learners in control group. These findings advocate that learners who played my-CEN serious game performed better as compared to other groups.

The findings also reflected that the effectiveness of a serious game could be increased when considerable attention was made to learner aspects particularly on their cultural background. Hence, this study demonstrated the association between culture and learning; which were consistent with other studies such as Economides (2008), Henderson (2007), Mohammed and Mohan (2011), Parrish and Vnberschot (2010), Swierczek and Bechter (2010) and Young (2008a, b).

Future studies should aim to include collaboration element. This option would require some redesign of the serious game model and my-CEN serious game. Additionally, findings conclude that the culturally-enhanced serious game is an effective learning tool to higher education learners. The implementation of the experiment however limited to ICT and BIS students from UTP who have experience playing computer games and the area that was being assessed was on IT-related discipline. More reliable results would be obtained if the experiment covers a wider range such as the whole population of students with diverse degree programs and different demography. However, conducting such research would entail significant labour due to the number of participants to be involved. Ideally such re-run would involve more lab facilities and logistics issues.

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