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Issues for Consideration to Adopt Educational Computer Games for Learning and Teaching

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Abstract— Computer games have started to gain attention in the domain of learning and teaching. The integration of computer games for education in the classroom has starting to gain acceptance in some countries. However, for schools which have never used computer games in the classroom, study still need to be conducted to investigate the teachers' belief and attitude toward the usage. The purpose of this paper is to examine issues for consideration when adopting educational computer games for learning and teaching. This paper also examines the concepts that related to educational computer games and aspects of learning and teaching. In addition, the theories of technology acceptance which use to assess the perception, belief and attitude of teachers and students have also been investigated.

Index Terms—Educational technology, Games, Learning systems, Technology transfer

I. INTRODUCTION

THE idea of using educational computer games for teaching and learning in the classroom has been applied in many schools and colleges in some countries [1], [2], [3], [4]. There are a number of cases showing that educational computer games can be utilized for educational purposes [1], [5], [6], [7], [8]. Computer games allow learner to progress on his/her own pace. It can draw the learner's attention and engage him/her into learning. Nevertheless, schools which have never used computer games in the classroom need to investigate the teachers' belief and attitude toward this usage. Research has shown that teacher's belief and attitude are one of the important factors affecting teaching computer or ICT use [9]. Moreover the methods of pedagogy approach including teaching and learning theories should also be examined. Hence, it is the purpose of this paper to review the issues for consideration before adopting educational computer games for learning and teaching. This review provides the concept of educational computer game, the pedagogy approach to the use of educational computer games and the technology acceptance theories.

II. FACTORS FOR CONSIDERATION

Two broad concepts are used as a guide to adopt educational computer games for teaching and learning. They are concepts under the umbrella of educational computer games and the adopting of technology theories as shown below [1], [7], [10], [11], [12], [13], [14], [15], [16]:

A. Educational Computer Games

- 1) *Edutainment*
- 2) *Pedagogy*
- 3) *Computer games*

B. Adopting of Technology Theories

- 1) *Technology Acceptance Model*,
- 2) *Theory of Reasoned Action*
- 3) *Belief about Teaching with Technology*

Under these two concepts, four main elements should be investigated. There are *edutainment*, *pedagogy*, *computer games* which are related to the area of educational computer games. Under “*adopting of technology theories*”, the elements include *Technology Acceptance Model*, *Theory of Reasoned Action*, and *belief about teaching with technology*. Each element is elaborated as follows.

Element1: Edutainment

According to Kirriemuir & McFarlane [1] learning-oriented games or educational computer game are known as “edutainment”. Educational computer games bring together the idea of game, play, fun, experience, hand-on and simulation in learning environment. Thus, it is the attempt of this paper to group the following three themes of learning related to edutainment.

1) *Learn through play*: Play is a natural and universal learning tool for children and adult. It is acceptable that the foundation of learning from childhood is through play. Lindon [17] pointed out “from babyhood, children use play to promote their own learning; they do not have to be persuaded into playing.” Though play, learner can develop, create, alter, resolve and understand. All these basic skills are developed as they explore, construct, imitate, discuss, plan, manipulate, problem-solve, dramatize, create and experiment [10]. The idea to modify traditional games and toys into the classroom become one of the most essential areas for psycho-pedagogy

[10]. Therefore, it makes sense to see play as an important activity within a school curriculum [18].

2) *Learn through doing*: There are three main learning styles most studies have identified [19]. They are visual learning, where learners prefer learn by reading and watching; auditory learning, where learners prefer learn by listening, discussion and talk things through; and kinesthetic learning, where learners learn by doing. Learn through doing is the process of actively engaging learners for hand on experience that will have benefits and learning consequences. In experiential education which related to learn through doing, the learner become more actively engage in the learning process and more independent in learning than in traditional didactic education. Lucker and Nadler [20] discussed the reasons why learn through doing is effective. They are equality, developing relationships quickly, disequilibrium, projective technique, decreased time cycle, chaos and crisis in a safe environment, kinesthetic imprint, encourage risk taking, diversity of strengths, and fun.

3) *Learn through simulation*: Simulations are experimental activities that have gain acceptance in classroom at all levels of education and training and in a variety of subject areas. A common definition of a simulation is a reproduction of an item or event which was created of an artificial world that approximates the real one [11]. Simulations can be used to present information and guide student and also test student's knowledge. Simulations allow students to explore situations that would be difficult, impractical, or impossible to duplicate in a classroom setting. Why people learn through simulation? The main reason is there is no risk involved in simulation. The application of simulation software teaches people to operate equipment that is potentially no dangerous to a beginner. In addition, simulation is less expensive; can perform the experiments repeatedly; more convenient than real experiences. According to Bitter [21], simulation overcomes the limitations of time. Students can travel to distance site. They can also wait for only short time to see the result of their experimentations, focus on special aspects of topics or event.

These three types of learning are somewhat related to edutainment. As edutainment is a form of integrating education with entertainment, learn through play is also integrating learning with fun and amusement. Edutainment is also a form of learn through doing [22]. Learn through doing, which is learn through direct experience, has been shown to be more effective and enjoyable than learn through 'information communicated as facts' [1]. Kirreimuir and McFarlane [1] claims two key themes common to the development of game for education are 1) learn through play and making learning fun is the motivational power of game, and 2) learn through doing in games such as simulation offers a power learning tool.

Element 2: Pedagogy

Research into the use of games in education is growing rapidly [1], [6], [14], [23]. In order to understand the potential role of mainstream games in supporting learning, we need to first answer the questions "what is learning?" and "what forms of teaching and learning are suitable for incorporating game in the classroom?" This is related to the pedagogical theory which includes instruction theory and learning theory. While instruction theory focuses on how to structure material for promoting the education of humans, learning theory is typically describe how people learn. Thus learning styles and teaching styles are investigated as follow:

1) *Learning Styles*: Learning style is useful in identifying the methods by which people prefer to receive information from their environment and undertake their learning. There are numerous models of learning styles available. In the past three decades, over 30 learning style assessment instruments have been developed [12], [24]. One of the well known and widely used instrument measuring learner perceived information is VARK Learning Styles [12]. These classifications, illustrated in table 1, have been termed visual learning, auditory learning, verbal learning (read/write) and kinesthetic learning.

Table 1: Perceived Learning Style

Auditory learners	Visual learners	Verbal learners (read/write)	Kinesthetic learners
Need to learn information from lectures, tapes and discussion.	Need to see information and watch presentations involving pictures, graphs, diagrams and visual media.	Need information displayed as word.	Need to feel and experience objects and concepts by handling, modeling or building.
Like to listen to others talk about ideas, concepts and objects.	Like to view and inspect material.	Like to read and write in all forms	Like to move round while completing tasks.
Learn through auditory repetition-remember what they heard.	Learn by forming pictures of objects and concepts remember what they have seen.	Learn by reading and taking note.	Learn by utilising fine muscle skills and/ or a whole body response-remember what they have done.
Favour the sequential presentation of information.	Favour holistic presentation of information.	Favour organising any diagrams and graphs into statements.	Favour hand-on approaches and direct involvement.
Often repeat to themselves what they are trying to learn.	Often close their eyes to reconstruct a picture of what they remember.	Often turn reactions, actions, charts, and flows into words.	Often exhibit a strong emotive response to what they are trying to learn.

(Adapted from: [12], [13], [25])

For the prefer learning style, some prefer to learn through reading and reflecting on how this might apply to their own situation, whilst others prefer to learn through trying ideas out and learn by reviewing their experience before planning the next step. Consequently, some development environments and education and training initiatives are believed to suit one type of person whilst another person will respond to different environment.

Honey and Mumford [26] learning style, as shown in and table 2, classified into four characteristics: Activist, Reflectors, Theorists and Pragmatists.

Table 2: Honey & Mumford learning style [26].

Characteristics			
Activists	Reflectors	Theorists	Pragmatists
<ul style="list-style-type: none"> - Immerse in new experience - Enjoy here and now - Open minded, enthusiastic, flexible - Seek to centre activity around themselves 	<ul style="list-style-type: none"> - Stand back and observe. - Cautious, take a back seat - Collect and analyse data about experience and events, slow to react conclusion - Use information from experience to maintain a big picture perspective 	<ul style="list-style-type: none"> - Think in a logical manner, rationally and objectively. - Assimilate facts into coherent theories. - Fit things into rational order. - Keen in basic assumptions, principles, theories, models. 	<ul style="list-style-type: none"> - Keen to put ideas, theories and techniques into practice. - Search new ideas and experimental - Act quickly and confidently on ideas, get straight to the point. - Are impatient with endless discussion

2) *Teaching styles:* As teachers, it is their job to be able to reach out to all of the students in order to let their students learn as much as possible. To understand the teaching style review in this paper, four types of teaching style according to Grasha-Richman [27] is investigated. They are Formal Authority, Demonstrator, Facilitator and Delegator. The Grasha-Richman teaching style is illustrated in Table 3.

Table 3: Grash-Richman teaching style

Teaching style	The Approach	Characteristics
Formal Authority	Instructor-centred	<ul style="list-style-type: none"> - Responsible for providing & controlling the flow of content - Not given a lot of time for student participation during class
Demonstrator	Instructor-centred	<ul style="list-style-type: none"> - Demonstrates & models what is expected - Acts as coached - Encourage student participate as important facet of lesson
Facilitator	Student-centred	<ul style="list-style-type: none"> - Facilitates & focuses on activities - Embrace group projects with peer-to-peer tutoring and learning group
Delegator	Student-centred	<ul style="list-style-type: none"> - Delegates & places much control for learning on individuals or group - Allow students to explore and design their own learning project

As mentioned above, in order to justify the use of educational computer games for teaching and learning, we need to fully understand the different teaching and learning styles. Future research is to investigate what styles of teaching and learning will be most suitable when educational computer games have been adopted in a classroom.

C. ELEMENT 3: COMPUTER GAMES

To justify the incorporation of computer games into the classroom, it is vital to investigate the genre and characteristics of the computer games.

1) *Genre of computer games:* As computer games have become more complex in terms of graphics, complexity, interaction and narrative, the genre of computer games have also increased [1]. There is, however, no standard categorisation of games but some generalized guidelines; different stakeholders in the games industry, developers, academic, web review sites, use taxonomy appropriate to their audience. Herz [28] presents these major categories: action games, adventure games, fighting games, puzzle games, role-playing games, simulations, sports games and strategy games.

2) *Characteristics of computer games:* To gain a better understanding of computer games for learning in order to create an evaluation framework for educational computer games, we have to consider these criteria when designing educational computer games for classroom [7], [11], [23], [29], [30] as illustrated in Table 4.

Table 4: Criteria and characteristics

Criteria	Characteristics
Rule	Games are rule-based. They are inherent in the game and govern the playing process.
Goals/ Objectives	Establish the game's rules of play and the criteria of winning, define the victory condition.
Active Engagement	Consistent active engagement provides an engaging fun to a learner
Challenge	Have a clear goal, preferably with multiple levels so that the feeling of challenge is continuous.
Competition	Clear defined competition, e.g., one player win, the other loses; contestants compete to achieve the highest score.
Content/ Story	Can be simple as instruction to the player; it describes why the players are there, what the goal is, what obstacles they will face along the way.
Curiosity	This is the motivation to learn; achieved by making the users' existing knowledge seem incomplete, inconsistent, or avidity
Fantasy	This makes game more interesting as well as increases efficiency of learning.
Immediate Reward	Learners need immediate response of what they have learned, also require immediate rewards which help to keep them highly motivated.
Interaction/ Interactivity	Design the way players interacts within the game world, e.g., the way they jump, shoots, or dunks; how they interact with their competition or enemies.

Of the many different types of games, educational computer games researchers appear to have concentrated on two types,

simulation and adventure [6], [31], [32]. In addition Amory and others' [14] research found that the adventure game appears to provide the best foundation for the development of teaching resources. However, apart from simulation and adventure, it is probable that other genres of game might be beneficial and appropriate for designing educational computer games. Future research aims to find the possibility of matching characteristics of each genre of the computer games to that of the educational criteria.

D. ELEMENT 4: ADOPTING OF TECHNOLOGY

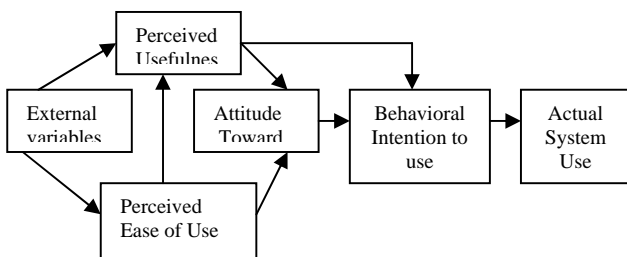
In adopting educational computer games for teaching and learning, teachers and students' beliefs and attitudes toward the implementation of this educational initiative are critical factors that determine what could happen in the classroom [8]. Research has also shown that teachers' beliefs are one of the important factors affecting teaching computer or ICT use in the classroom [9].

In order to measure the perception, belief, and attitude in adopting educational computer games in the classroom, the following technology acceptance theories such as Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA) and Concept of the Beliefs about Teaching with Technology (BATT) are investigated.

1) *Technology Acceptance Model (TAM)*: Many studies have been conducted in the area of IT adoption and acceptance in order to identify the factors determining the uptake of a particular information technology. One of conceptual models that were developed from other models was the model proposed by Davis [15]. The Technology Acceptance Model (TAM) was specially developed in order to explain individual use of IT. TAM was developed by adapting the theory of reasoned action (TRA), diffusion of innovation and social-cognitive theory [33].

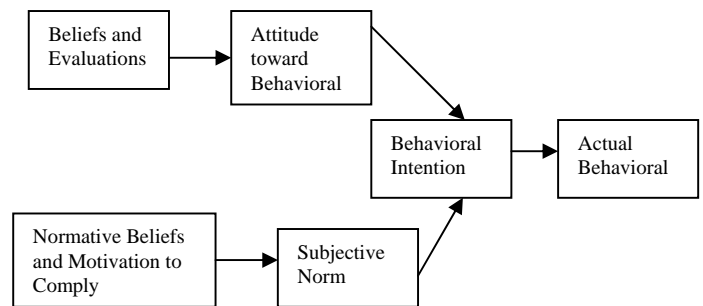
TAM, illustrated in Figure 1, predict IT use with two constructs, perceived usefulness and perceived ease of use. TAM has been tested to explain or predict behavioural intention on a variety of technologies such as word processors [8], [34], spreadsheet software [34], email [34], [35], voicemail [34], graphics software [34] and net conferencing software [36]. Thus the technology acceptance model has been shown to be a valid model over a variety of commercially available technologies that are primarily used in an office environment or educational environment [15], [34], [35].

Figure 1: Technology Acceptance Model



2) *Theory of Reasoned Action (TRA)*: TRA, illustrated in Figure 2, was used to study human behaviour and develop appropriate intervention. This theory provides a framework to study attitudes toward behaviour. According to the theory, the most important determinant of a person's behaviour is behaviour intent. The individual's attitude toward the behaviour includes; Behaviour belief, evaluations of behavioural outcome, subjective norm, normative beliefs, and the motivation to comply.

Figure 2: Theory of Reasoned Action



3) *Beliefs about Teaching with Technology (BATT)*:

Based on Ford's motivation system theory items for the Beliefs about Teaching with Technology instrument (BATT), this instrument measured the school leaders and teachers' beliefs concerning support factors that affect technology integration [16]. In relation to technology integration in schools, environmental context beliefs would include things such as administrators, teachers, students, parents, buildings, equipment, and professional development. Based on Ford's theory, this environment or context would influence teachers' integration behaviour. This also suggests that context beliefs or perceived behavioral control are important factors for explaining educational technology use.

These three theories are the predictable tools to the acceptance of educational computer games for both teachers and students. They can be predicted in term of perceived usefulness, perceived ease of use, subjective norm, actual behavioral and the school support factors that influence the technology acceptance of teachers.

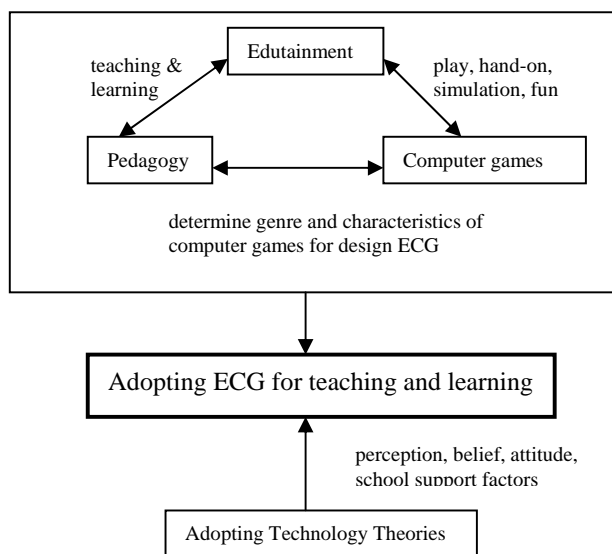
III. DISCUSSION

Computer games and gaming studies have diffused in many areas including teaching and learning, but in the field of educational gaming, it is still lack of a comprehensive framework for exploring the role of the games for teaching and learning [4]. It is the attempt of this paper to propose the issues for consideration in adopting educational computer games for teaching and learning. Four main elements have been investigated as mentioned in section II. Element 1: Edutainment has been studies as a foundation of educational computer games in teaching and learning environment. Three

types of learning related to edutainment namely “learn through play”, “learn through doing” and “learn through simulation” are investigated to support the concept of the use of educational computer games which bring together the ideas of fun, experience, hand-on and simulation in learning environment. Element 2: pedagogy which refers to teaching and learning styles is studied in order to explore the proper styles which could be a good matching to the use of educational computer games in classroom. The pedagogy element also relates to the study of genre and characteristics of computer games in term of determining the appropriate genres of computer games for designing useful educational computer games use in a classroom.

The fourth element: adopting technology theories might not be directly related to the first three elements, but it is one of the vital issues needed to be taken into account when considering. In order to adopt innovation, it needs to explore the perception, belief and attitude of people who involved in this usage. The relation of four elements for consideration to adopt educational computer games for teaching and learning is illustrated in figure 3.

Figure 3: The relation of four elements for consideration to adopt educational computer games (ECG) for teaching and learning



IV. CONCLUSION

Education computer games can make a momentous and positive contribution to the classroom if carefully incorporated into everyday learning. Educational computer games are designed with special educational goals which are aware in both the requirements of the teachers and the educational needs of the students. The use of educational computer games will continue to grow [4]. So, it is essential that the game technology should be incorporated into the education framework carefully. The responsibility is not only with the teachers supplying the material, but also with those who

develop the games, content and design, and with the students who use them. If responsibility is taken, educational computer games have enormous potential to enhance the learning experience within existing educational framework [4]. It is the purpose of this paper to introduce the issues for consideration when adopting educational computer games for teaching and learning.

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