CREATING EFFECTIVE EDUCATIONAL COMPUTER GAMES FOR UNDERGRADUATE CLASSROOM LEARNING: A CONCEPTUAL MODEL

By

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ABSTRACT

When designing Educational Computer Games, designers usually consider target age, interactivity, interface and other related issues. They rarely explore the genres which should employ into one type of educational game. Recently, some digital game-based researchers made attempt to combine game genre with learning theory. Different researchers use different pedagogy conceptions. The purpose of this paper is to investigate the appropriate computer genre in designing effective educational computer games that can be used as learning tools in Thai undergraduate classrooms by integrating the learning conceptions from the previous work of those researcher's. The following steps are used to conduct this study: summarize the survey of Thai students' opinions toward game genre; analyse the characteristics of genre of computer game; match those characteristics of genre with learning theories; and propose the conceptual model from the comparison. The results of this analysis can be used as a guideline for Educational computer game designers in considering appropriate genres of game for education purpose.

INTRODUCTION

Computer and video games are becoming popular due to the fact that youth today are growing up with technology and playing games become part of their daily activities. On average, the children between 2 and 18 years of age spend 20-33 minutes a day playing digital games. Boys between the age of 8 and 13 spend most time playing digital games with an average of 47 minutes per day (Green & McNeese, 2007). Computer games have taken over as the medium of choice of entertainment. Game as a medium is not only good for entertainment, but also has huge potential in education. Game researchers like Prenskey (2001), Gikas & Van Eck (2004), Boop (2007) and Gee (2003) confirm that computer games can be effectively used for learning and teaching. Computer games can be used to give a better form of education and can even make computers become the unique tools of learning (Jayakanthan (2002). Thus, the idea of using computer games for learning has gained more attention in recent years.

Educational games have been widely used in schools both in primary and secondary levels. The Interactive Digital Software Association (Van Eck, 2005) reported that 35% of game players are under the age of 18, 55% are; male; 43% are female, and 43% of game players are in the age group of 18-49 . From the figures, it implies that people have played computer game significantly in colleges and universities. But the idea of bringing this educational technology in tertiary level has just begun in some countries. Unfortunately, there is scarcely any research on educational computer game for tertiary level in Thailand. Game researchers also attempt to design the effective educational computer games for classroom environment. Variety of aspects brought into considerations include: gender, level of age, racial diversity, number of players and the role of teachers.

Apart from these, quite a few computer game researches focus on analyzing educational design with learning conceptions. Some examples of researchers on game-based learning like Prenskey (2001), Gikas & Van Eck (2004), Boop (2007) and Gee (2003) attempt to analyze game genre to support learning theory. The question that follows is "what appropriate game genres can be used for education purpose?" This paper attempts to answer this question.

Consequently, the authors conducted a survey of the Thai students from four universities, two private and two public, which are both in metropolitan and regional areas. Nineteen participants were interviewed with the above question. Participants provided variety opinions. Most of them claimed that selection of appropriate game genres for learning is based on the learning contents and subject areas. Thus, the authors carry on this finding by further investigating the learning conceptions. Subsequently, it came up with four sub-query concern with learning theories which will relate to and be supported by the game genre. They are (i) what should learner learn from each particular genre? (ii) what level of the learner's intellectual skills is required to reach these learning objectives? (iii) what should be the matter or subject to reach these objectives and match the characteristic of particular genre?, and (iv) what kind of learner should learn this learning content and use particular genre? Hence, the learning theories of Bloom-learning objectives (Bloom (1956), Gangé-learning capabilities (Gagne, Briggs & Wager (1992), Prensky-learning content (Prensky (2001) and Honey and Mumford-learning styles (Honey & Mumford, 1992) have been examined to answer the above 4 questions respectively. Eventually, the conceptual model of game genre that supports the learning theories has been proposed as a guideline for designing effective educational computer games. This paper will begin with the overview of IT and digital game markets in Thailand in order to pave the background of how the game industry in Thailand is growing. This will be followed by the genres of games in education environment, and game genre supported pedagogy theories.

1. Overview of IT and Digital Game Markets in Thailand

The computer gaming industry in many countries has become bigger than other entertainment business such as movies and music. The digital game industry in Thailand is also expanding considerably with the government support under the National IT plan (Thuvasethkul and Koanantakool, 2002). IT 2000 has provided the framework and guideline for IT policies and initiative for five years. After that the National IT Committee (NITC) conducted a research and developed a ten year National IT Policy for the period 2001-2010 called IT 2010. IT 2010 identified five main goals that have to be developed as follows: e-Society, e-Education, e-Government, e-Commerce, and e-Industry.

In e-Education aspect, educators tend to concentrate on what a specific ICT technology can and cannot do for education. Even though many of the technologies have similar characteristics, one technology may have different potentials depending on the purpose of using it (Haddad and Jurich, 2002). As illustrated in Table 1, Personal Computer and Internet have high flexibility and interactivity.

It is observed that while gaming industry in Thailand is growing rapidly, computer games are not widely used for teaching in tertiary institutions.

2. Genre of Computer Games in Education Environment

Computer game genres have been organized in many ways. Computer game experts classified them into various categories. Crawford (1984) divides genres of computer game into 2 broad groups: (i) Skill-and-action games including Combat Skill-and-action games: Combat Games, Maze Games, Sports Games, Paddle Games, Race Games; and (ii) Strategy games comprising of Adventures, D&D Games, Wargames,

Technology	Outreach	Flexibility	Sensorial Stimulation	Interactivity
Radio	High	Limited	Audio only	Limited
Television	High	Limited	Audio-Visual	Limited
Video	Low	High	Audio-Visual	Limited
Computer	Low	High	Audio-Visual	High
Internet	Highest	High	Audio-Visual	High

Table 1. ICT and their potential for education (Haddad and Jurich, 2002)

Games of Change, Educational and children games, and Inter personal Games. Bergeron (2006) concludes that the standard genre of game encompass Action, Adventure, Arcade (Retro), Combat (Fighting), Driving, First-Person Shooter (FPS), Military Shooter Multiplayer Puzzle Real-Time Simulation (RTS) Role Playing Game (RPG) Shooter, Simulation, Sneaker, Sports, Strategy, Third-Person Shooter (TPS), Trivia and Turn-Based. While Prensky (2001) affirms that computer games are generally recognized into eight genres consisting of action, adventure, fighting, puzzle, role-playing, simulation, sports and strategy games, most games fall within a particular category. Some bridge different gaming styles and, thus, could appear under more than one category simultaneously. For instance, Battle, Racing, Fighting and Shooting games are subcategory of Action games. Strategy games may include Puzzles and Adventure games on the gameplay. Additionally, Role Play games may be a sub-genre or special type of Adventure games.

Among those genres of games, some are more popular than others. From GMNews: Discussion on Game Genre (GMNews, 2008) some claim that First Person Shooters and Role Playing Games have pretty much dominated the market for a good few years now. Some argue that they don't think any genre has an advantage over the others. There are many games of different genres that have also become very successful. According to the survey of the games genres that Thai students play recorded from 4 universities, Strategy, Role Play and Sport games is the most popular game genres they play respectively (Table 2).

The summary of game genres classification in this paper, were selected and integrated from the standard genre categories described by Bates (2004), Burn & Carr (2006), Wolf (2002) and genre from the research finding of Thai students. The following category of game genre, alphabetically, provides definitions, characteristics, and examples of game titles as illustrated in Table 3.

3. Computer Game Genre for Pedagogy: Thai Students' Perspective

Generally, game experts or game developers also classify educational games as one genre of computer games. Distinguishing from other game genres, the particular purpose of educational games is to teach or train with explicit educational goals and is based on an actual curriculum. The emphasis is on teaching a specific body of knowledge. Rather than being structured as a straight-forward set of lessons or exercise, these programs are structured like games, with such elements as scoring, timed performance, or incentives given for correct answers. Educational games consist of variety of general game genres and it is difficult to categorize them specifically (Schiffer, 2006). Amongst different genres, researchers Quinn (1994), Roberts, (1976), Ju & Wagner (1997) appear to concentrate on the two types, simulations and adventure. Quinn (1994) confirmed that the adventure game genre appears to provide the best foundation for the development of teaching resources. In addition Kirriemuir & McFarlane's survey (2003) discovered most education games belong to strategy and simulation. The question that follows is: "Besides those genres mentioned earlier, are there any genre that can work well in education environment?"

Game genre	Frequency	Percentage
Action	52	5.0
Adventure	52	5.0
Battle	10	1.0
Music (song) game	93	8.9
Fighting	8	0.8
First Person Shooter	21	2.0
Flight Simulator	2	0.2
Puzzle	93	8.9
Racing	33	3.2
Real Time Strategy	233	22.5
Role Play Game (RPG)	216	20.8
Sport game	156	15.0
Shooter	69	6.7
Total	1,038	100.0

*Respondents can answer more than one game genre

Table 2. Game genres that Thai students from four universities play

To answer this question, the authors interviewed 19 participants from four Thai universities. The results are illustrated in Table 4.

According to the participants the game genres which appropriate for education environment are action games, adventure games, puzzle games, racing games,

Game genre	Explanation of Genre	Example of game title
Action Games	The most well known genre & the largest class of computer games. Keeps the player moving and involved all the times. Does Not require deep thinking, primary skills are hand/eye coordination & quick reflexes. It is often about fighting, battle, shooting, racing and highly intense physical play.	Beat-em-up, Survival Horror,Unreal Tournament,Doom, Quake, issile Command
Adventure Games	Focus on storytelling & narrative. Players must move through a complex world, accumulating tools, overcoming obstacle until finally reaching the treasure or goal. Game play typically needs logical thinking & persistence from the player.	Adventure on the ATARI 2600, Gabriel Knight, Indiana Jones, Monkey Island, Time Zone, Wizard and the Princess.
Fighting Games	Sub-genre of action games & is one of the major computer games. Games involve characters who fight usually hand-to-hand, in one-to-one combat situations. Fighters are represented as humans or anthropomorphic characters. The goal is to create quick bursts of swift and intense action.	Bloody Roar, Dead or Alive, Double Dragon, Fight Unlimited, Mortal Kombat, Starmaster, Street Fighter, Tekken, Virtua Fighter.
Music Games	Include Rhythm and Dance Games. Game play requires players to keep time with a musical rhythm. This grouping of games is differentiated by the timed elements usually synched to music somehow. Many require a specialized controller like DDR, but not all. May include controller simulating drums, turntables, guitars or maracas.	Beatmania, Bust a Groove, Dance Dance Revolution, Donkey Konga, Eyetoy Groove, Guitar Freaks, Para Para Paradise, Pon 'n' Music, Space Channel 5.
Puzzle Games	Require the player to solve logic puzzle or navigate complex locations. Not surrounded with story or actions. Most puzzles should present without time pressure, but the rules must be clear.	Atari Video Cube, Devil Dice, Intelligent Qube, Jigsaw, Mercury, Myst, Puzzle Bobble.
Racing Games	Using motorized vehicle to move faster than an opponent to reach a specified goal or beat a specified time. Usually racing games use cars, but motorcycle, power boat, and flight/space racing games also exist.	APX skiing game DOWNHILL, Dog Daze, Indy500, Night Driver, Street Racing.
Role Playing Games	Player assumes the roles of fictional character and collaboratively creates stories. The characters may include specifics such as species, race, gender, occupation or also include various abilities: strength and dexterity.	Anvil of Dawn, Diable, Dragon Lore 2, Rivers of MUD, Sacred Pools, Sunflower, Unsafe Haven, Zodiac.
Simulation	Contain a mixture of skill, chance, and strategy to simulate or try to accurately depict real world situations, physics, and events as accurately as possible. There are several categories of simulation games: Racing Simulators, Flight Simulators and 'Sim' type games	Flight simulators: Microsoft Flight Simulator 2000: Racing Simulators: NASCAR; 'SIM' type: SimCity-Brotherbund
Shooter Games	Focus on shooting & often destroying. Sometime called Shoot-Em'-up. Requires the player to blow enemies or objects in order to survive and continue game play.	Asteroids, Berzerk, Centipede, Duckshot, Galaga, Missile Command, Starwar, Tempest
Sports Games	Games that simulate the playing of any sporting activity. Focus on planning & management. Have to know the rules right but can also let players change them. It may let the players to customize the game to suit for themselves.	Tiger Woods, PGA Tour, NHL 2004.
Strategy Games	Emphasize on thinking, rationalizing, theorizing, problem-solving, etc. The focus is the combination of analytical skill & tactics. Require more time to play. Need balance resource, just enough information provide for motivation and interest.	Chess Games, Civilization, Command and Conquer, Final Fantasy, Tactics, Ogre Tactics, Roller Coaster Tycoon.

Table 3. Characteristic of game genre

What game genres do you think are appropriate for education environment?	Frequency	Percentage
Action Games	1	5.2
Adventure Games	6	31.6
Puzzle Games	3	15.8
Racing Games	2	10.5
Role-Playing Games	5	26.3
Simulation Games	8	42.1
Sports Games	6	31.6
All game genres	10	52.6
Depend on content & subject areas	5	26.3

*Participants can answer more than one opinion

Table 4. Game genres which appropriate for education environment: interview results from Thai teachers and students

role-playing games, simulation games, and sports games. Among these range of genres, the top three most appropriate access along to the genres participants are Simulation games (42.1%), Adventure games (31.6%) and Sport games (31.6%) respectively. Conversely, there were three participants who thought that violent game genre such as Fighting and Shooting Games are not suitable to pertain in learning situation. Some argue that "it is not a genre but a content that increase in violent, aggressive or sexual areas". However, most of them thought that every genre of game can apply to educational games (52.6%). Those who gave this opinion indicated that it depends on the content and subject areas of what will be taught. Subsequently, the authors pursue another question: "What subject areas do you think educational computer games can best support? Why?" The results are shown in Table 5.

In addition to the information in Table 5, six participants indicated that educational computer games can support almost every subject area. Some of them added the comments of game genre which is suitable for some subjects, for example, role-playing games for 'law' when people are in the court; simulation games for learning content which is risky or need an experimental basis.

In brief, the findings imply that not any particular game genre is the most suitable for learning and teaching. Every genre can be considered but depends on the learning content and subject areas. For further study in

Learning Content	Subject areas
Communication	Journalism, new report, Advertising, Tourism
Experiment & Risk	Human anatomy, Medical Science, Surgery, Chemistry
Fact	Laws, Political Science
Language	Vocabulary, Grammar, Foreign language
Management	Planning, Business, Accountcy
Memory	History, Archaeology
Motor skill	Sports, Physical Education
Procedure	Cookery Science, subjects related to 'How to'
Reasoning & Logic	Mathematics, Arithmetic, geometry

Table 5. Subject areas which educational computer games can best support: interview results from Thai students

this matter, some other learning theories should be taken into account. Those learning theories will be discussed in the following section.

4. Game Genre and Pedagogy Theories

To understand educational gaming and fully utilize the power of this digital technology in the classroom, several pedagogy theories need to be emphasized and examined in order to develop a framework for the deployment of computer games for learning. Different researchers on game-based learning use different pedagogy concepts to analyse games in the use of learning environment. One of these is Prensky (2001) who claimed that teachers have to understand the type of learning content. Prensky proposed the relationship of learning content, learning activities and possible game style. Gee (2003) also attempted with a list of 36 learning principles in computer games which contain 12 principles. Gee's principles are strongly centred on the traditional ways of guided leaning by doing. Boop (2007) proposed a framework to answer three main questions that are important to educational game design. These questions are: (i) what actually is the learning purpose? (ii) what is and should be the material used to reach these goals? and (iii) how should this learning content be learnt?. Boop (2007) proposed three subfields of didactic analysis analysis of learning goal, analysis of learning content, and analysis of learning and teaching method to answer the above three questions. Gikas and Van Eck (2004) used theories of Gagné's learning capabilities and Bloom's taxonomy to compare with Bate's (2004) Game taxonomy.

The above literature review, reflects back to the purpose of this paper which is to answer the main question: "What is the appropriate game genre to design educational computer games?" Prior to this question, there are four sub-queries concerned with learning theories which will relate to and be supported by game genre. They are: (i) What should learner learn from each particular genre (learning objective)? (ii) What levels of the learner's intellectual skills is required to reach these objectives (learning capability)? (iii) What should be the matter or subject to reach these objectives and match the characteristic of particular genre (learning content)? and (iv) What kind of learner should learn this learning content and what learner's behavior match the characteristics of particular genre (learning style)? Hence, this section will provide the basic concepts of each learning theories and reflect on these four sub-queries. The learning theories and concepts include: Bloom's Leaning Objectives, Gagné's Learning Capabilities, Prensky's Learning Contents, and Honey and Mumford's Learning Style.

4.1 Learning Objectives

Bloom's (1956) taxonomy of educational objectives includes three domains: cognitive (about knowledge), affective (about attitudes) and psychomotor (about doing). Among these three domains, cognitive domain is the widely accepted system. It was classified into a hierarchy of skills ranging from knowledge, comprehension, application, analysis, synthesis and evaluation. He stated that the main reason in constructing taxonomy of educational objectives is to facilitate communication. An awareness of these levels can help one determine how well students really know the course content. A hierarchy of six levels, description (learner action), and key verbs associated with each cognitive domain, and some potential IT activities are illustrated in Table 6.

Level	Description (Learner action)	Key verbs	Potential IT activities
Knowledge	Recall previously learned material	Define, repeat, identify, list, label,	Find answers to quiz question from internet
Comprehension	Grasp meaning, explain, restate ideas	Describe, pick, choose, review, discuss, pick	Use *PowerPoint* to make a cartoon, or make a newspaper report
Application	Use learned material in new situations	Apply, use, solve, interpret, employ	Use *Publisher* to create a board game, make a storyboard of book using *PowerPoint*
Analysis	Separate material into component parts & show relationship between parts	Analyse, detect, compare, inter, test, conclude	Identify relationships between information using the charting features of *Excel*
Synthesis	Pull together separate ideas to form a whole	Arrange, create, collect, predict, combine, plan,	Use *Dreamweaver* to construct a web site which helps solve an everyday problem
Evaluation	Make judgments about the value of materials or methods	Assess, decide, judge, revise, select, test	Use *email* to engage in an online forum debating the issues

Table 6. Bloom's Cognitive Objectives group by level, description, key verbs and potential IT activities (Bloom, 1956; Dalton, 1986)

4.2 Learning Capabilities

Gagné's taxonomy of learning states that there are five major categories of learning outcome: verbal information, intellectual skills, cognitive strategies, motor skills and attitude. The five subcategories of intellectual skills are hierarchical in nature (low level skills to high level skills). Intellectual skills are the capabilities that make the human individual competent. They enable him/her to respond to conceptualizations of his/her environment. Gagné's hierarchy of intellectual skills follows programmed instruction since one skill must be learned before another can be mastered. Five levels of learning capabilities are illustrated in Figure 1.

4.3 Learning Contents

Prensky discussed about how to combine gameplay and learning in his paper "Computer Games and Learning: Digital Game-Based Learning". He claimed that teacher has to understand the types of learning content. With different kinds of learning content, teacher can see what kind of learning are really going on such as learning fact, skill, judgment, theory, reasoning, process, procedure, creativity, language, system, observation and communication. Additionally, teacher can choose

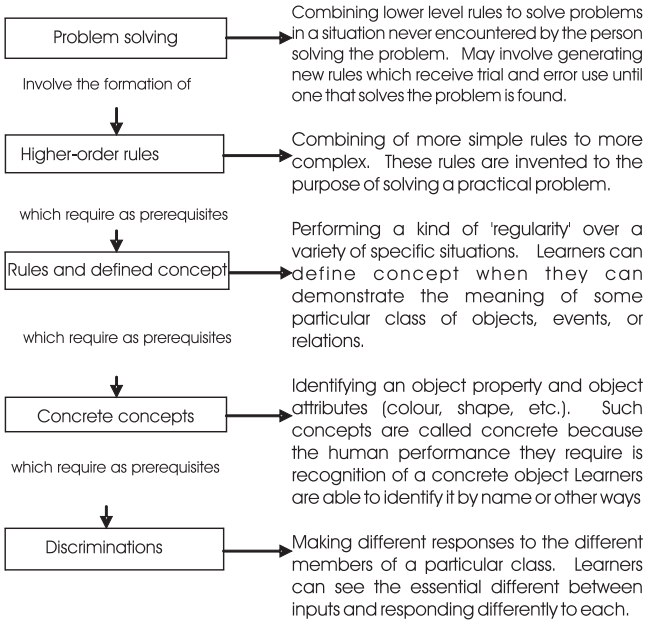

Figure 1. Gagne's intellectual skills of learning capabilities

different learning activities according to particular types of content. Prensky proposed the relationship of learning content, learning activities and possible game type as illustrate in Table 7.

4.4 Learning Style

Learning style is useful in identifying the methods by which people prefer to receive information from their environment and undertake their learning. Among the learning styles which are classified as experiential, Honey and Mumford learning style is one of the well known experiential learning. These learning styles are easy to remember, widely understood, accepted and used by most learners. Honey and Mumford (1992) classified learners into activist, reflector, theorist, and pragmatist. The four styles are as shown in Table 8.

There is an attempt to integrate learning style with game genre as appeared in Rapeepisarn (2008) and Dondlinger (2007). They proposed a new conceptual model of relationship between game genre, learning activities and learning style by bridging the gap between the Prensky (2001) and Chong's et al (2005) studies. They argued that Prensky choose all standard game categories of computer games matching with learning activities and learning content, but these is lack of the comparison with learning style of the users. While Chong

Learning content	Learning Activities	Possible Game Styles
Facts: Law, politics, product	Questions, association, memorization, drill	Game show competitions, flashcard type game, mnemonics
Skills: interviewing, teaching, management	Imitation, feedback, coaching, continuous practice	Persistent state games, role-play game, detective game
Judgment: management, decisions, timing, ethics	Reviewing cases, asking questions, feedback, coaching	Role-play games, multiplayer interactive, adventure game, strategy game, detective game
Behaviors: supervision, self-control, setting example	Imitation, feedback, coaching, practice	Role-play games
Theories: marketing rationales, how people learn	Logic, experimentation, questioning	Open ended simulation games, building game, construction games
Reasoning: strategic & tactical thinking, quality analysis	Problems, examples	Puzzle
Process: Auditing, strategy creation	System analysis & deconstruction, practice	Strategy game, adventure games
Procedure: assembly, bank teller, legal	Imitation, practice, play	Timed games, reflex games
Creativity: invention, product design	Play	Puzzle, invention games
Language: acronyms, foreign language	Imitation, continuous practice, immersion	Role-play games, reflex games, flashcard games
Systems: health care, markets, refineries	Understanding principles, graduated tasks	Simulation games
Observation: models, morale, inefficiencies, problems	Observing, feedback	Concentration games, adventure games
Communication: appropriate language, involvement	Imitation, practice	Role-play games, reflex games

Table 7. Summary of Prensky's Learning Content, Learning Activities and possible Game Styles

and others investigated the behaviour of each learning style while playing game, only three different game genres are studied. Rapeepisarn and others' model is illustrated in Figure 2.

The list of game genres from the survey are classified into 13 genres according to which Thai students play (as shown in Table 3). Those genres are somehow overlapping and some can be classified as sub-genre of another. For example, Action Games fall into things that have to shoot, or race; Battle Games can be sub-genre in Fighting Games; Music Games may take variety of forms and often group with Puzzle Games due to their common use of "rhythmically generated puzzles". Thus, in this paper game genres are regrouped into 8 categories and are compared to learning objectives, learning capabilities, learning contents, and learning style as a model shown in Figure 3 and Table 9.

Learning Styles	Characteristics	Play Game Behavior
Activists	Immerse in new experience, enjoy here & now, open minded, flexible, enthusiastic, Seek to centre activity around themselves.	Prefer working as a team, being a group leader, Be able to brainstorm to solve the problems.
Reflectors	Stand back & ob- serve, cautious, take a back seat, collect & analyse data about experience & events, slow to react con-clusion, use infor-mation to maintain a big picture per-spective.	Go through the important data in the game, follow the instructions, spend a long time before making decision, not to lead the game.
Theorists	Think in a logical manner, rationally & objectively, assi-milate facts into coherent theories, fit things into ra-tional order, keen in basic assumptions, principles, theories, models & thinking system.	Go through the data and follow the instruction before the start of the game, be able to give careful thoughts when choosing the game elements, Formulate good strategy to defeat the enemy.
Pragmatists	Keen to put ideas, theories & tech-niques into prac-tice, search new ideas & experi-mental, act quickly & confidently on ideas, get straight to the point, be patient with endless discussion.	Follow closely the instructions & strategies that were mentioned in the briefing, believe they can play better if they were given proper instruction.

Table 8. Characteristics of four styles of learning (Honey & Mumford, 1992) and their behavior when playing game (Chong et al, 2005)

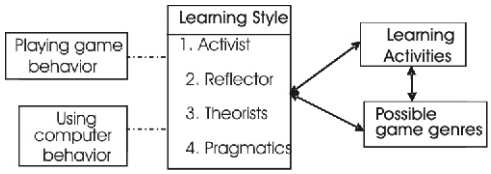

Figure 2. Conceptual model of relationship of learning styles, learning activities and possible game genres

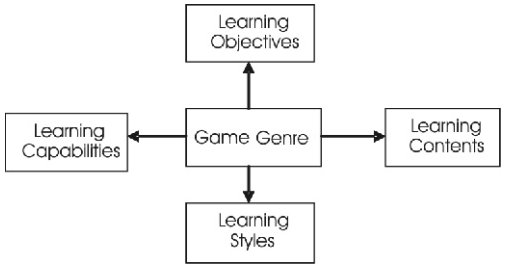

Figure 3. Integrated game genres to support learning concepts

Game Genres	Learning Objectives	Learning Capabilities	Learning Contents	Learning Styles
Action	Application Comprehension Knowledge	Defined Concepts Concrete Concepts Discriminations	Facts, Skills	Activists
Adventure	Evaluation Synthesis Analysis Application Comprehension Knowledge	Problem Solving Higher Order Rules Defined Concepts Concrete Concepts Discriminations	Judgment, Process, Observation, Skills	Reflections
Fighting	Application Comprehension Knowledge	Defined Concepts Concrete Concepts Discriminations	Facts, Skills	Activists
Puzzle	Comprehension Knowledge	Concrete Concepts Discriminations	Reasoning, Creativity	Pragmatists
Role Playing	Evaluation Synthesis Analysis Application Comprehension Knowledge	Problem Solving Higher Order Rules Defined Concepts Concrete Concepts Discriminations	Skills, Judgment, Behavior, Language, Communication	Activists
Simulation	Evaluation Synthesis Analysis Application Comprehension Knowledge	Problem Solving Higher Order Rules Defined Concepts Concrete Concepts Discriminations	Theories, Systems	Reflectors, Theorists
Sports	Application Comprehension Knowledge	Defined Concepts Concrete Concepts Discriminations	Facts, Skills	Activists
Strategy	Evaluation Synthesis Analysis Application Comprehension Knowledge	Problem Solving Higher Order Rules Defined Concepts Concrete Concepts Discriminations	Judgment, Process	Theorists

Table 9. Comparison of game genres to support learning objectives,learning capabilities, learning contents and learning styles

Discussion

Good educational computer games provide not only an attractive context for engaging learners in activities, but also need to deliver substantive educational content to achieve learning objectives. Educational computer games require strategizing, hypothesis testing, or problem-solving, usually with higher order thinking than repeated memorization or simple comprehension (Dondlinger, 2007). However, in creating effective educational computer games, creator have to match particular education topics or content into the structure of game. Basically game creator usually takes demographic data, age, gender, racial diversity role of the teachers, into account when designing games. Several researchers on game-based learning (Prensky (2001), Gikas & Van Eck (2004), Boop (2007), Gee (2003) attempted to analyze the instructive methods by which computer games support learning. Nevertheless, there are many pedagogical principles which exist. Some of those principles are really useful. For example, the theories of well known and widely accepted such as Bloom's Taxonomy of Learning Objectives; Gangé's intellectual skills; Honey and Mumford's Learning Styles; and Learning Content of Prensky match to possible game types. It is the attempt of this paper to compare these learning conceptions with game genres. The model of integrating is shown in Figure 3. The process that led to this new model is conducted by (1) matching the characteristics of game genres with Prensky's learning contents and learning activities, (2) analysing learning activities of each genre with Bloom's taxonomy and Gangé's intellectual skills, and (3) compare the behavior when playing game Chong et al (2005) of each style of learning (Honey & Mumford, 1992) with each game genre. In order to make this model comprehensive, comparison of game genres to support the learning concepts is illustrated in Table 9.

The results of this analysis will be a tangible framework for choosing game genres for designing an effective educational computer game. This framework can also be used as a criterion to answer the question "What is the appropriate game genre to design educational computer game?" Interestingly, Adventure, Role-Playing, Simulation and Strategy Games reach all levels of learning objectives and capabilities. All these four game genres are also mentioned in the findings of most researchers Gee (2003), Quinn (1994), Roberts (1976), Ju & Wagner (1997) that they are good foundations of the development of teaching resources. On the contrary, Puzzle games which fall into the least levels of learning objective and capabilities are also used widely in educational game. One of the survey's participants suggest the use of Puzzle games for the novice game

players. This genre of game involve solving logic puzzles or navigating complex locations such as Maze. Most puzzles should present without time pressure, and it is extremely important that the rules be clear. The interface should be simple and allow for trial and error without penalty by making it easy to reset the problem or undo a particular move (Schiffer, 2006). As for Action Games, generally it is the most well known genre, reaching three levels of learning objectives and capabilities, and also Fighting and Sports Games as well. While in Adventure games, the players must have patience and require a great deal of thinking, Action Games have to be fast and keep the players moving at all times. Additionally, in terms of selecting the appropriate game genres for a particular style of learner, it can be determined by looking at learner's dominant learning style.

Wolf (2002) and Schiffer (2006) suggest a guideline for designing effective educational computer games that includes clear goal, target age , interactivity, simple interface, engage the emotion, often reward the player, not creating a game first and then take on some educational value at the end. Game designer should work closely with subject matter experts, and have concern with content (what are we teaching?) and context (what is the storyline of game?)

Conclusion

Educational computer games are increasingly used as a learning tool in colleges and universities in some countries. However the research on using educational game in tertiary level in Thailand is rather scarce. Apart from considering gender, age, culture, racial diversity, language, and nurture as part of game design, researchers on computer game-based learning attempt to analyse the use of computer game with pedagogy theories. Some of those are learning contents with possible game genres (Prensky, 2001); taxonomy of games with Gagné's learning intellectual skills and Bloom's taxonomy (Gikas and Van Eck, 2004, Bate, 2004); didactic analysis with learning goals, learning contents, and learning and teaching methods (Boop,2007); possible game genre with learning contents and learning styles (Rapeepisarn, 2008, Dondlinger, 2007). Based on some findings from the Thai students and integrating the works of researchers on digital game-based learning, the authors attempt to answer the question "what appropriate game genre can be best used in education environment?" After summarizing the opinion from the interview of Thai students, they come up with other four sub-queries concerned with game genre and learning conceptions. Subsequently, the four pedagogy theories namely Bloom's taxonomy of learning objective, Gagné's intellectual skills of learning capabilities, Prensky's learning contents compared with game genres and Honey and Mumford learning styles have been integrated to answer the questions. Finally, the conceptual model that shows the comparison of the use of computer game genre supporting learning theories has been proposed. It is hoped that findings from this research will be useful in designing educational games in the future.

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