Adapting Learning Theories in
Mobile Game-Based Learning Development

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Abstract— The learning experiences through mobile device can be expected from the learning activities and the mobile contents such as games and mobile applications. This paper presents an approach to develop a mobile game-based learning (mGBL) by adapting a review of learning theories and approaches. The review reveals a few characteristics that interconnected to the mGBL. In adapting the characteristics, mGBL is developed based on the concept of values in 1Malaysia. The approach reveals that the mGBL is considered successfully developed. The main deliverables of this study are the mGBL characteristics mapped with learning theories and approaches, the mGBL application and the development stages. The developed mGBL has potential to be a learning tool and marketed since it seems unique to Malaysia. The development stages employed to the mGBL development were successfully implemented, simple to follow, and provided an easy guideline for developer to develop similar concept of mGBL.

Keywords-mGBL; mobile game-based learning; learning theories; mobile game; game development

I. INTRODUCTION

mGBL is a game-based learning that utilizes mobile technologies such as mobile phone, PDA and handheld devices as the playing platform. Mohamudally [1] describes that the concerning issues of mGBL are mobility, restrictions on mobile technologies, pedagogical theory that be adjusted to the technical capabilities of current standard mobile phones. mGBL applications are developed for a broad variety of learning contexts [1], [2], [3]. Games are known as effective platforms to motivate people to play, interact, communicate and as well as learn. Game and learning can be successfully developed and implemented in learning environment by combining both game design and instructional design approaches and by considering various issues such as learning theories, theory of play, mobile platform and technologies (for mobile games), game design, instructional design and others.

II. OVERVIEW OF LEARNING THEORIES

There are various different theories of learning. These available theories are useful to consider their application to learning environment. Some theories focus on ways to describe and control observations, behaviours, and events of learning. Others attempt to describe the frameworks of learning such as the nature of attention, the way memories are formed, and the way learners process and give meaning to knowledge. Therefore, learning theories are likely to fall into several main paradigms, including behaviourism, cognitivism, and constructivism; which briefly described in this section.

Kang [4] described that behaviourism theory started in the early 20th century and the proponents are Bandura, Watson, Skinner, and Pavlov. Behaviourism is known as a paradigm that assumes learner is passive and responds to environmental stimulus [5]. The learner starts from knowing nothing and then his behaviour is shaped through reinforcements (positive or negative). Both positive and negative reinforcements increase the probability that the antecedent behaviour will happen again. On the contrary, punishment decreases the likelihood that the antecedent behaviour will happen again. Hence, this theory describes that learning happens when a correct response is demonstrated. The strength of this theory is when the learners are focused on a clear goal, they can respond automatically to the cues of that goal. This will realize the learning objectives. On the other hand, the weakness is when the learners may find themselves in a situation where the correct response does not occur, the learners cannot give response. This theory has been criticized because it can be applied in a situation where the learning environment is at the lower level of skill or knowledge. Conversely, this theory can be applied successfully when the learning environment supports the good and immediate responses [5].

The revolution of cognitivism has replaced behaviourism in the 1960s as the leading paradigm [4]. The focus of cognitivism is on the inner mental activities of the human mind because it is precious and necessary for the understanding of how people actually learn [5]. Mental activities such as thinking, knowing, memorizing, and problem-solving are focused in this theory which creates the knowledge. The knowledge can be seen as schema or symbolic mental constructions. According to Kang [4], this theory has been widely used and impacted the learning environment. Kang further describes that the cognitive process is the main focus for learning resources. As to differentiate with behaviourism, learning is a change of knowledge state. The strength of this theory is that learners

are trained to do a task in similar way to allow consistency. This will make the learners solve a problem using their own possible solutions. However, the weakness is when the learners are able to accomplish a task, but not through the best suited way to the learners.

In constructivism, learning is seen as an active process of constructing knowledge rather than acquiring it [5]. Knowledge is created based on learners' experiences and interactions. They actively construct or create their own understanding by assembling knowledge from diverse sources appropriate to the problem at hand. New information is gathered by linking to prior knowledge and experiences. Constructive theory is the main contributor toward the successful learning process in 1990s [4]. This theory focuses on the learners rather than instructors. Individual learner is unique and has own capability of learning. He is encouraged to show his skills and potential those are useful for him in the learning environment. Vygotsky's social development theory is one of the foundations for constructivism which stresses on keys on human development such as interpersonal (social), cultural-historical, and individual factors [5]. The advantage of this theory is when the learner is able to understand various realities, he is better able to deal with real life situations. If a learner can resolve problem, he may better apply his existing knowledge to other circumstances [6]. On the other hand, in a situation where agreement is essential, different thinking and action of different people may cause problems especially when the situation needs only the right and exact decision [6].

III. IMPLICATIONS OF LEARNING THEORIES TO MGBL CHARACTERISTICS

Developing instructional tools requires specific elements which include learning theories and instructional design model. The designers are required to embed the learning theories into the design and adopt the instructional design model during the development of instructional tools. Table I and Table II show the summary of the characteristics of these theories that can be adopted when developing mGBL.

TABLE I. MGBL CHARACTERISTICS

Behaviourism
- State objectives and break them down into steps.   - Provide hints or cues that guide players to desired behaviour.   - Use consequences to reinforce the desired behaviour.   - Provide good feedback and response to the players.
Cognitivism
- Organize new game information.   - Link new game information to existing knowledge.   - Use techniques to guide and support learners' Attention, Encoding, and Retrieval process.   - Provide good screen design, interface and navigation.   - Supply variety of game resources for choices and game options.   - Provide adventures storyline and game play.
Constructivism
- Pose good problems -realistically complex and personally meaningful.   - Create group learning activities.   - Model and guide the knowledge construction process.   - Offer different types of game levels, game play, and challenges.

TABLE II. MGBL ADVANTAGES FROM THE LEARNING THEORIES [7]

Behaviourism
- Behaviourism provides the concept of repetition & reward.   - The player practices in a game through repetition while receiving rewards after each proper response.
Cognitivism
- Cognitivism attempts to build intrinsic motivation by integrating learning and game experience.   - Player engages in a discovery process through a game experience that integrates learning and play akin to the limitations and potentials of the human mind.
Constructivism
- Constructivism provides game challenges that offer player to solve problem in the game environment.   - Challenges can be solved through player's experiences in previous game level.

It can be summarized that the characteristics in the learning theories should be adopted in the development of mGBL. Behaviourism stresses on the reinforcement and control to the learner by providing good feedback from the game. In cognitivism perspective, the game should facilitate the support of transferring, remembering, and recalling knowledge in learner's memory. From constructivism approach, the learner should be given opportunities to explore and acquire knowledge that they want.

IV. LEARNING APPROACHES FOR MGBL CHARACTERISTICS

Various learning approaches have been discussed in available literatures and these approaches are underlying from the three basic paradigms; behaviour, cognitive and constructive theories. Multiple intelligence theory [8], and nine events of instructions [9] are seen to be more of interest to this study and have been applied to many learning environments [10]. These approaches are discussed in relation to the mGBL in this section.

Gardner [8] pioneered the nine multiple intelligences theory to account a broader range of human ability. Generally, this theory provides nine potential pathways to learning. It is believed that individuals will naturally learn best under one or more of their intelligences. Therefore, the learning systems should be most effective if different intelligences are incorporated into the learning environment. In general, the theory of multiple intelligences gives impact to learning in three aspects [8]: (i) curriculum needs to incorporate these intelligences such as arts, self-awareness, communication, and physical education; (ii) instructional methods should appeal to all the intelligences, such as role playing, musical performance, cooperative learning, reflection, visualization, and storytelling; and (iii) assessment of learning should measure and take into account the multiple forms of intelligence. The nine intelligences, as proposed by Gardner, are: i) linguistic intelligence (the ability to master languages- spoken and written), ii) logical-mathematical intelligence (the capacity to analyze problems logically and scientifically), iii) interpersonal intelligence (the ability to understand and relate to other people), iv) intrapersonal intelligence (the capacity for understanding oneself), v) spatial intelligence (the ability to know and react

to the space), vi) bodily-kinaesthetic intelligence (the capacity for moving around using own body), vii) musical intelligence (skill in the performance, composition, and appreciation of music), viii) naturalist (thinking through nature and natural forms), and ix) existential (sensitivity to complex issues surrounding our existence, and developed skills in pondering deep questions).

In relation to this study, in order to know how mGBL provides the multi intelligence approach to learning, Table III maps the link between multiple intelligences and mGBL characteristics. Although not all intelligences can be applied in an mGBL at any given time, a few intelligences are potentially applicable. In fact, mGBL can make players become so engaged by addressing these types of intelligences, where each player has an opportunity to take advantage of his/her own particular strengths [10].

TABLE III. MULTIPLE INTELLIGENCES MAPPED TO MGBL CHARACTERISTICS

Intelligences	Descriptions
Linguistic	In a game, the linguistic elements can be in a form of written words and narrations such as instructions, user guides and game play.
Logical-mathematical	Strategy in game is one of essential features which need players to have logical thinking. Solving problem in mathematical strategy also includes in this type of intelligence.
Interpersonal	In a game sometimes needs players to interact with other players (multi-player) or their own (single player). Therefore, competition and collaboration might occur to get the game victory.
Intrapersonal	Challenges in a game encourage players to solve problem by exploring and interacting within the game. This interaction might include emotional and mental challenges.
Spatial	Game always gives visual space in various formats such as colours, 2D or 3D. This space makes players interact actively in the space provided.
Bodily-kinesthetic	This aspect give players to interact physically in the game with bodily movement such as hands, foots and other body parts.
Musical	This aspect is important to game. Audio and music effects give fun elements to players. The aspect can be in a form of background music or sound effect.
Naturalist	This concept provides the experience with flora and fauna in a game. Apart from that, the geographical elements are also included in this aspect.
Existential	Player should feel as a good and important character in a game world. This aspect provides the responsibly to the game environment that should have for game players.

Gagne [9] has published a book that identifies the mental conditions for learning. From that, he created a nine-step process called the events of instruction, which correlate to and address the conditions of learning. The nine events of instructions are useful for instruction designer to develop an effective learning system. These events include: i) gaining attention, ii) informing learners of objectives, iii) stimulating recall of prior learning, iv) presenting the content, v) providing "learning guidance", vi) eliciting performance (practice), vii) providing feedback, viii) assessing performance, and ix) enhancing retention and transfer. Table 4 shows the brief descriptions of the nine events of instructions which can be associated with mGBL. Table IV shows the brief descriptions of the nine events of instructions which can be associated with mGBL.

TABLE IV. NINE EVENTS OF INSTRUCTIONS LINKED TO MGBL

Events	Descriptions
Gain attention	In a game, has an attractive introduction screen accompanied by sound effects startles the senses with auditory or visual stimuli. E.g.: game montage introduction screen and interesting graphics.
Inform learners of objectives	The instructions, game rules, and game objectives to be achieved are provided in game,. These initiate the internal process of expectancy and motivate players to complete the game.
Stimulate recall of prior learning	A simple way to stimulate recall is to challenge players in different types of game level. The higher is the level, harder of completing the task. This process makes players learn and remember the previous tasks completed in previous game levels.
Present the content	This aspect gives players various types of challenges for know their skills. Game content should be organized meaningfully. To appeal to different learning modalities, a variety of challenges should be used if possible.
Provide "learning guidance"	Additional guidance should be provided in a game. Guidance strategies include the use of examples, user manual, or tips. A good game is when players do not refer to game manual as they can learn by themselves while playing.
Elicit performance (practice)	The players are required to practice the new skill to finish the game. This provides an opportunity for players to confirm their correct understanding, and the repetition increases the likelihood of their retention.
Provide feedback	It is important to provide good feedback in a game. Feedback in a game can be formed in scores, graphics, timing and audio.
Assess performance	Assessment acts as one of the feedback systems in a game. Each player should be informed their level of performance so that they can play until game ends.
Enhance retention and transfer	This aspect is provided in a game with a various types of level. Players need to remember and use their skills to further playing the game. They can use their own strategies to success.

V. MGBL OF 1M'SIA GAME DEVELOPMENT

A mGBL about local learning content that could cultivate and foster the concept of 1Malaysia (http://www.1malaysia.com.my) is produced. The game is named 1M'sia which is abbreviated from one Malaysia. The 1M'sia mGBL development is primarily based on the concept of "edugaming" by [11], "game-based learning" by [12], and mGBL by [13] which focuses on intertwining learning and gaming.

TABLE V. 1M'SIA MGBL CHARACTERISTICS

Learning Theories	1M'sia mGBL Characteristics
Behaviour	In 1M'sia mGBL, objectives are stated and broken down into game steps. The game also provides hints that guide players for playing and give good feedbacks and responses.
Cognitive	1M'sia mGBL provides simple screen design, interface and navigation to successfully running in mobile devices.
Constructive	1M'sia mGBL models and guides the knowledge construction process through the game environments. It also offers great game play and simple challenges by learning 1Malaysia values and concepts.
Multiple Intelligences	Four intelligences such as linguistics, spatial, musical, and existential are adapted in 1M'sia mGBL. The linguistic elements in a form of written words such as instructions, user guides and game play. The 2D space in 1M'sia mGBL makes players interact actively in the space provided. Audio and music effects give fun elements to players. Player should feel as a good and important character in a game world.
Events of Instructions	All nine events of instructions are adapted in 1M'sia mGBL. The game starts with gaining attention to player by providing attractive introduction screen accompanied by sound effects. The game ends with the assessment marks or game score.

The characteristics of 1M'sia mGBL are adapted from the learning theories and approaches discussed in previous sections. Although not all characteristics are adapted, a few are obvious to be implemented in 1M'sia mGBL characteristics. Such characteristics are illustrated in Table V. The mGBL development for this study is implemented using the Flash tool. Four design and development phases are involved which adapted some activities from [14]: (i) Analysis (ii) Game Design (iii) Development, production and integration; and (iv) Evaluation. In the analysis phase, the target user is defined which range from 9 years old children to adult. Besides, the mobile technology and restrictions are analyzed for the targeted platform. The most important aspect is the learning content analysis. The values of 1Malaysia concept are chosen for the learning content of the mGBL. In the game design phase, a group of activities are conducted such as storyboarding, game flow design, interface design, and navigation structure design. From here, the real development phase will then take place. In the development phase, all game sources are integrated through authoring and programming steps using Flash. The game resources include graphics, animation, text, and sound, which provide the learning content. At the final phase, the game is tested for verification to ensure that the game is playable at mobile phone without errors and bugs. Amendments are made for any errors occurred during testing. Lastly, the game is deployed to mobile phone and available for playing.

A. Learning Content of 1M'sia mGBL

Malaysian local content is urgently required especially for education, entertainment, and games [13]. Therefore, the mGBL learning content is produced from the 1Malaysia concepts and values (http://www.1malaysia.com.my). The mGBL can subtly assist users in learning the useful information that the values of 1Malaysia are conveying. This is necessary for the successful of promoting harmonious and unity amongst the multi-ethnic citizen of Malaysia. The values of 1Malaysia that are integrated in the mGBL learning contents provide the basis of the game play, game rules and game actions. The 1Malaysia formula is conceptualized for implementation in two main aspects. The first is through the assimilation of the (i) Principles of Unity, while the second aspect is the assimilation of (ii) Aspirational Values. Such values that are incorporated in the mGBL:

- Principles of Unity
  - Acceptance amongst all races and peoples of Malaysia. The game shows how to shake hands with others.
  - Humility in forming decisions and actions. The game shows the important of queuing.
  - Mutual respect to others. The game guides to know and respect other races, cultures as well as to elderly people.
- Aspirational Values
  - Integrity in all matters and transactions. The game portrays the responsibility on tasks/ jobs.
  - Culture of education. The game shows the situation in school.

- Culture of precision in terms of time management and improving efficiency. The game demonstrates the time management policy.

B. 1M'sia Game Play and Flow

The 1M'sia mGBL is aimed at demonstrating the values and challenging knowledge capabilities of the players of 1Malaysia values. In general, the game is generated into two game plays which are simple quiz and mix-and-match. Players act as a Malay character and then are triggered with several situations which provide the 1Malaysia values. Such situations are an ATM machine, a traditional costume shop, a house, a group of people, a school, and religious places. The players then have to enter the situation for the game environment. The players' skills and knowledge will determine how well they are able to do the right things, and the values will either be mastered or not. At the end of the game main environment, the player is shown to their own score of the level of their 1Malaysia concept comprehension. If the score is more than 70%, player's comprehension is acceptable for the knowledge level.

C. mGBL Screen Shots

The following screen shots Fig. 1 to Fig. 3 show the game interface and screens of the 1M'sia mGBL. At the beginning, when the game is loaded, the main screen is put on view. Players then can start to play the game by pressing start button or selecting other options for instructions. The game will start at the main game environment, and players can control the game by pressing the arrow and selection keys. Fig. 1(a) shows the main environment of the 1M'sia mGBL. Fig. 1(b) and 2(b) are examples of situations that player will be triggered. For example, in Figure 1(a), when player enters the situation, a short animation will be displayed which shows the 1M'sia value and then gives a simple quiz.
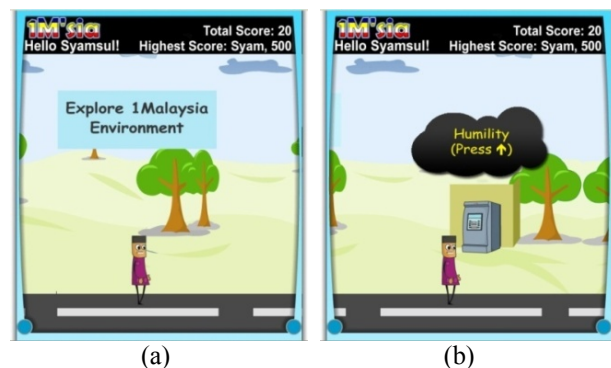

| (a) | (b) |

Figure 1. Example of a mGBL Screen Shots

The example shown in Fig. 2(a) is the Humility quiz. Once the answer is selected, a score will be shown. After that the player will get back to the main environment to proceed to the subsequent situations provided in the main game environment. Fig. 3(a) show the examples of a mix-and-match game where the player needs to match the correct traditional costumes for a specific ethnic group in Malaysia.

The game immediately informs the player whether the answer is right or wrong. Fig. 3(b) illustrates a simple summary given at the end of the game, where the player is informed of their total percentage that player has been achieved. The percentage indicates the level of player comprehension of 1Malaysia values.
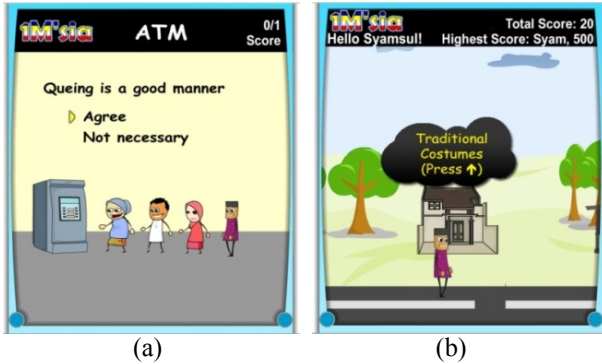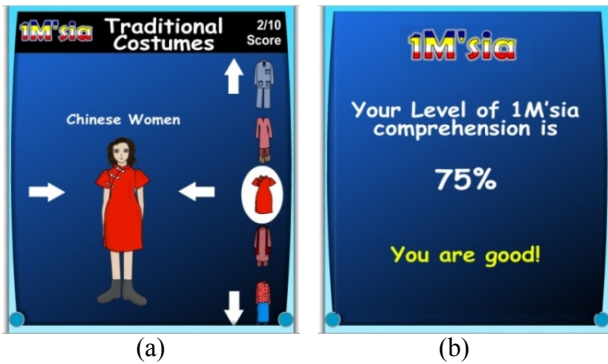

Figure 2. Example of a mGBL Screen Shots

Figure 3. Example of a mGBL Screen Shots

VI. DISCUSSION AND CONCLUSION

This study proposes a mapping between some learning theories and approaches to mGBL. Having these mGBL characteristics, a mGBL application has been developed specifically for Malaysian local content. The study also briefly describes the design and development process and suggests that key design decisions were informed by theory in the learning sciences. In this respect, this may be of interest to fellow game developers. The main deliverables of this study are the mGBL characteristics mapped with learning theories and approaches, the mGBL application and the development stages. The development stages employed to the mGBL development were successfully implemented, simple to follow, and provided an easy guideline for developer to develop similar concept of mGBL. Future works can be suggested for this study, for example the complete user evaluation study for further data analysis and hypothesis testing. In addition, although the mGBL application is developed to comply with several theories, it is needed to address the innovations and contributions of this study by comparing the mGBL with the existing ones. Moreover, an experiment is needed to evaluate the effectiveness of the application.

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