Uncover the Ambiguity between GBL and CAI

Tsung-Yen CHUANG[a], Yen-Ru SHI[a*], Tsun-Hung TSAI[a], Chi-Yu YANG[b],
Shu-Yuan TAO[c], Jung-Tsan MA[a], Sheng-Hsiung SU[a], & Yu-Jen HSU[a]
[a]*Department of Information and Learning Technology,*
National University of Tainan, Taiwan
[b]*National Cheng Kung University Institute of Education, Taiwan*
[c]*Department of Digital Technology and Application,*
Chungyu institute of Technology, Taiwan
yenru@moke.tw, chuangyen@mail.nutn.edu.tw

Abstract: Researches on GBL have become popular in recent years; however, the definitions of a "game" still remain unanswered. The study aims to clarify the relations between GBL and tradition CAI and compare their differences. CAI emphasizes teaching; games focus on entertainment; GBL is the combination of CAI and games. CAI and GBL have their own features that can be used in the digital learning field. The study presents a fundamental basis to clarify CAI and GBL and proposes future implications of GBL for further reference to develop a system for GBL.

Keywords: Game-based learning, computer-assisted instruction, serious game.

Introduction

Digital era has impacted oncoming generation of technologies and resulted in various influences on information technology development and its applications. One of the emergences is in the educational field which researchers have devoted to the areas of digital games to trigger participants' learning motivation, so as to compensate the disadvantages of the traditional lecture methods that cannot attract learners' attention [21]. It is called "Game-based learning"; learning via digital games is an interactive piece of technology within a multimedia environment expected to effectively increase the learning interests. However, when a device is a computer, the difference between Game-Based Learning (GBL) and Computer-Assisted Instruction (CAI) still remains unexplained. Besides, the definition of GBL is uncertain, instead of having an inexplicit conception that the GBL is to facilitate learning by playing game only. Schell [15] indicated a game contains several elements, such as goals, conflicts, rules, won and lost, interactions, and challenges. Moreover, the essentials of a game should actively attract players' attention, engage them in the game, and inspire their own internal value. Meanwhile, it allows players to immerse themselves in a gaming situation.

Most researches on GBL demonstrate that utilizing the pedagogy of GBL in learning not only motivates the learning engagement but also promotes the learning achievement. The ambiance of GBL impresses game players with fun as well as creates a gaming environment that makes them immerse themselves into it. On the other hand, it may cause the drawback of applying GBL if the game does not attract learners to play. When it fails to be an entertaining GBL, learners would rather take a traditional lecture. However, many studies claimed that applications of games in a system are really not such GBL which not

only demonstrate a poor screen interface design but also guide learners in an iterative practice mode that lacks both interaction and variation to encourage learners to play. Thus, this kind of the system appears to be on the level of a computer program or CAI, yet being interpreted as GBL, the reason of which is presumably caused by the intention to enhance the visibility of the research.

Computer-Assisted Instruction (CAI) is a teaching method via computer technology. During the past thirty years, applying CAI in courses has been not only a trend in the educational field but also a blooming in educational researches [2][5][13]. In contrast with the CAI, GBL was emerged in nearly ten years and has encouraged researchers to investigate the effectiveness in cultivating learning. However, GBL is considered as a kind of CAI if the entertainment of GBL is absent. In addition, owing to the maturity in the development of CAI, a few artifacts of CAI have integrated the game elements in the products of CAI. It is imperative to clarify the definition and scope between GBL and CAI. Therefore, the study aims to uncover the myth and clarify the boundaries between GBL and CAI so that researchers are able to concentrate on the issue of applying GBL in the realm of educational study, rather than perverting the effectiveness of CAI and GBL.

1. Literature Review

1.1 Computer-Assisted Instruction

Computer-Assisted Instruction (CAI), Game-based Learning (GBL), and serious games are common terminologies in the field of digital learning. These terms are different from each other but share some similarities. The review on the related literatures indicated that CAI is a teaching method that adopts computers as a teaching media to present well constructed materials on computer screens for the learners. It directly utilizes computers to present learning materials and control the process of teaching and learning [11]. Characteristics of CAI include vividly presenting learning content in different ways, interactive teaching and immediate feedback, facilitating individualized learning and remedial teaching, providing privacy, and unlimited learning time and opportunities.

Sipple and Sipple [17] indicated that the educational concept of CAI is to arrange students in an interactive computer course that selects an appropriate topic or lesson based on their previous learning responses and allow them to adjust their progress in accordance with their ability. Chou [3]had narrow and broad definitions for CAI; the narrow definition is that CAI adopts the content of the computer program as a learning source, whereas the broad definition is that the computer program provides instructional support in learning activities for both teachers and students.

Nowadays, the monotonic text and graphical user interface of CAI cannot motivate learners to engage in learning; various digital materials, such as animation and video, usually are remixed and integrated into the development of CAI. Moreover, the popularity of digital games makes the traditional CAI combine game elements to attract learners' attention. However, it does not mean that CAI is equivalent to GBL, as CAI is not recognized as a game. For example, Figure 1 is a snapshot of the G4C [8], a CAI system, with the integration of some game elements, such as maps, coins, levels, skills, props, and Internet connection. If the competitiveness of the game is also available in the G4C, it would include most game elements in CAI. However, this G4C eventually is considered as CAI rather than a game for students. Apparently, even though a CAI system has remixed the game elements, it cannot become to the GBL system. There still are some significant differences between CAI and true GBL, as the G4C may be simply considered as a Game-Based CAI.
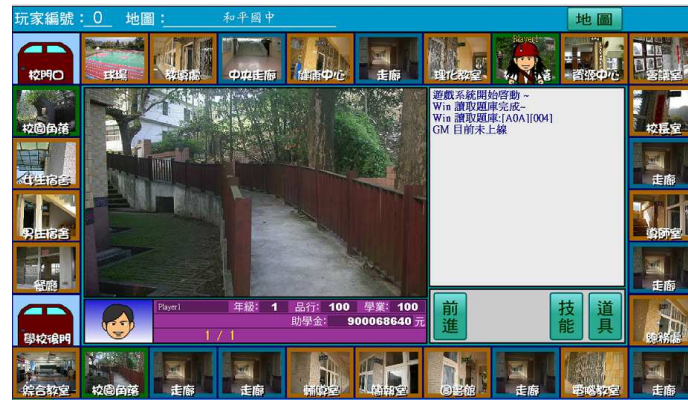
Figure 17. The snapshot of G4C [8]

1.2 Game-Based Learning

Game-based learning (GBL) is to provide learning content, restructure participants' cognition, solve problems in tasks, and represent behaviors based on the game design to represent game concepts [1]. Therefore, participants can learn behavioral techniques and apply them in tasks to develop self-efficacy and assimilate in different situations to change behaviors and transfer learning. Killi [12] pointed out that learners actively construct knowledge in the learning process; learning through the game playing enables them to have flow experiences. Flow is the most ideal learning process such as a person is fully immersed in an activity. Games can raise learning motivation, sustain learning interests, and increase learning effectiveness. Game-based learning theory means that learners learn in the context of the game; since they are willing to actively learn in the context of the game, their learning willingness can be reinforced through the process of the game playing.

The biggest challenge of the educational game design is how to balance the attractive game elements and educational goals. Killi [12] proposed three main issues that need to take into account before designing educational games; they are storytelling, balancing games, and optimizing cognitive load. Gee [9] stated that a good gameplay should comply with the educational theories, promote learning, and transfer knowledge and skills. Robertson and Howells [14] adopted educational games to conduct a research and found that the role of teachers is not to provide knowledge anymore but to encourage learners to learn through observations and discussions. If educational games usually require students to do repetitive practices, students tend to be bored and would not learn from games.

Sub Cat [20] is an iOS game (See Figure 2), and the purpose of this game is to train players' hand-eye coordination ability. The Sub Cat is certainly a type of GBL because children immerse in the game scenario and learn unconsciously. Recently, there are many GBL Apps deployed to mobile platforms that fulfill learning contents and motivate learners to learn and play with fun.
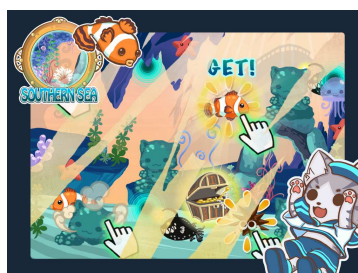

Figure 18. The snapshot of Sub Cat [20]

2. Discussion on CAI and GBL

2.1 Relation between CAI, serious games, and GBL

GBL is different from CAI; the purpose of GBL is to have "fun", from which most players even do not notice their learning behaviors. Din [7] had pointed out that a successful educational game should have five components described as follows: (1) The game must be immersive; (2) the game should have high playability; (3) the game should be attractive, challenging, and competitive; (4) the game must provide one or more goals that allow players to achieve; (5) players can track and manage their progresses in the game. Thus the characteristic of "entertainment" is essential in GBL. Consequently, when compared with CAI, GBL puts more emphasis on the game itself. Additionally, game-based CAI combines game theories with products of CAI technology to attract students' attention to lessons through game playing [4]. The board definition of CAI is computer based teaching activities that include GBL. Moreover, GBL is an educational application of digital games. Obviously, CAI and games are entirely different, though they may share some similarities with GBL (See Figure 19).
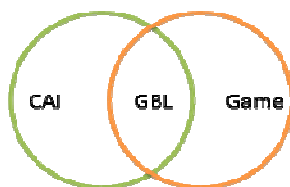

Figure 19. Relations among CAI, GBL, and Game

The other term is serious games which apply digital games in other professional fields, such as education, medical treatment, and politics. For example, U.S. Marine Corps used DOOM as a training tool for a tactical simulation; the medical field adopts simulation games to train their staff in surgical training. According to the definition of serious games, GBL could be considered as a branch of serious games applied in the field of education but having some differences [6].

What elements are added in CAI to make GBL? "Game elements" is generally being considered; when a game includes learning contents, it is GBL. When designing a GBL game, a game designer, who has extensive experience in game design and may not be specialized in education, has to make more efforts to consider whether the learning content is appropriately presented and arranged to make students learn something. Nevertheless, educators have to consider whether the GBL games are entertaining [19]. If the answer is negative, those games may be considered as CAI. In this vein, the learning contents and game elements should be remixed in the game-based learning environment in a seamless manner. One example is the research of Gunter et al. [10] which asserted the academic content is endogenously immersed and embedded within the game's fantasy and story context to promote the knowledge transfer as well as encourage players or learners in pursuing academic achievement. Both the game elements and learning contents are indispensable in developing a game-based learning system. Whereas, the CAI, an educational tool, should be involved in learning contents and in the digital games composed of the game elements. Apparently, GBL is the intersection of CAI and the digital game (See Figure 19).

Serious games are applications of games in education which makes learning interesting but does not reduce player's perception of learning behaviors. However, comparing with GBL, the serious games emphasize learning contents and accommodate educational purposes which may result in less entertainment [16]. Therefore, serious

games are in the ambiguous zone between CAI and GBL. In fact, CAI, GBL, serious games, and digital games are sharing some similarities; as learning contents and game elements are highly correlated among them (See Figure 20). Consequently, as shown in Figure 20, the placement of a developed game-based learning system is uncertain, and thus, it largely depends on the extent of more or less entertainment in the learning contents.

Figure 20. Relations among CAI, GBL, Serious Games, and Digital Games

Though many researchers pointed out the necessary game elements for GBL or the frameworks of the game designs, the definitions of CAI and GBL still remain unclear. Researchers have different views that cause a vague definition of GBL. Some researchers claimed that once players have fun or flow experiences during the game playing demonstrated in the experiments and questionnaires, and then the whole process is deemed as GBL. The related literature of digital games from 2005 to 2009 showed that definitions of digital games remain unclarified for the reason that the term, digital games, is popular so that people do not misinterpret it.

2.2 Roles of CAI and GBL

A system employs the computer and information technology in teaching and learning could be categorized into the CAI system. The mission of applying the CAI is to assist teaching, and thus the effective way to assess effectiveness of the CAI is to evaluate students' learning effects. In this vein, the CAI could be applied in all disciplines to facilitate learning either in classroom or after-school. However, the instructional effectiveness of a game is often evaluated based on observations of whether players increase motivation, establish social skills, or change learning attitudes during the game playing rather than emphasizing the knowledge acquisition mechanism [10]. Therefore, GBL allows the learners to learn knowledge unconsciously. Consequently, the assertion of applying GBL and CAI is significantly different. Even CAI having associated with some game elements, it could not become GBL. For game players, GBL is a game, instead of a learning system. However, the ultimate goal of GBL is to facilitate learning rather than for entertainment. Thus when employing GBL in learning, it should contain learning objectives and well constructed instruction to scaffold the learners toward the learning objectives. On the other hand, designers of GBL should stand on the point of view of game designers to develop a GBL system and ensure the GBL system is entertaining.

GBL is not all academic subjects because the center of GBL is a game. Therefore, evaluating the effectiveness of GBL should concentrate on enhancing and maintaining the learning motivation rather than learning achievement. While a GBL system involves more learning contents and focuses excessively on evaluating the learning effects, this GBL system has approached the position of CAI as shown in Figure 20. Apparently, even though researchers and scholars believe that GBL is an excellent mode of learning, the actual impact on student learning is still limited. Thus, GBL is difficult to replace CAI. As a result, the applications of GBL should not be limited to the academic disciplines conventionally but crucially discover a better fit of application. Steinkuehler [18] indicated that a massively multiplayer online game is a matter of the situated community structures and practices that allow players to learn through full participation in a genuine game play; it demonstrates that the ambiance of the game entails the affordance of community of

practices. Even more, the potential of applying GBL in a learning activity could cultivate the creativity, problem solving ability, and cognitive skills [22]. On the other hand, the role of GBL in a classroom is to facilitate individuals to learn independently, promote collaborative learning, adapt to different learning issues. GBL can further take an important role in the realm of digital learning.

Conclusions and Future work

It is important to further specify the essential and sufficient elements of games and to merge them with learning contents to form GBL. The current education researches indicated that selecting an appropriate construct and integrate it in learning content according to different personal preferences, backgrounds, environments, and educational courses to better facilitate teaching.

Many researchers and scholars mentioned the essential characteristics of GBL. For instance, Prensky [22] indicated that the characteristic of GBL involves entertainment, games, rules, goals, interactions between computer and human, results and feedback, adaptability, sense of victory, conflict competitiveness and challenges, problem solving, social interactions, images and stories. Additionally, Prensky [22] and Shih et al. [16] synthesized nine common characteristics of games from several studies which include goals and tasks, challenge, authenticity, exploration, interactivity, feedback, competition, cooperation, and learning after action. These characteristics of games can assist game designers to develop a well established GBL system. However, up to now, there has been a lack of uniform criteria in common elements of GBL. Besides, even though a digital learning system has involved in the characteristics of GBL, it could not conclude that a digital learning environment is same as a GBL system. As mentioned in the previous literature review, a CAI system could merge these characteristics but not fulfill the essential of a GBL system. Hence, there must be some key factors result in a huge difference between CAI and GBL.

In addition, the flow is the most ideal learning process, such as a person is fully immersed in an activity, Killi [12] indicated learning through the game playing enables learners to have flow experiences. Moreover, when playing a game, the degree and situation of immersion relies on individuals' interest and perception. Consequentially, the flow experience cannot be interpreted as peremptory criterion to examine the effects of applying GBL, as this is just for reference only.

This study aims to clarify the definition of GBL and further to explore the differences between GBL and CAI. While manipulating a real GBL system, learners pay full attention to gaming scenarios try to reach new goals and overcome challenges, rather than perceiving the learning contents and goals. On the other hand, if a GBL system is not attractive, then this GBL shall be faded away and toward a CAI system. However, regardless of CAI, Game-based CAI, serious games, and GBL, it is important that a useful system should facilitate learning and engage students in learning. Designing a GBL system is not a simple task; there still are some unresolved issues that worth to discuss, such as the scope of application, the model of success, and the pedagogy role. Based on the assertion of this study, it provides a fundamental basis of GBL, illuminates the related studies of GBL, and facilitates researchers to avoid perverting the scope of CAI in the future.

Acknowledgements

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