Combining Game Based Learning and Flipped Classroom - An Analysis Based on Affordance Theory

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Abstract. Affordance theory was first proposed by Gibson and this theory has been applied by several scholars to the problem of relationship analysis in different fields. In this paper, based on a combination of 19 literatures, some definitions of game-based learning (GBL) and flipped classroom are reviewed.The affordances of both of them is derived for comparison and validated in a case study of teaching physics concepts and a case study of teaching chemistry labs, respectively. Ultimately, it is found that GBL can make up for the problems reflected in some of the literature of flipped classrooms making students feel stressed and struggling to keep up with each other with a sense of engagement and ease of learning; and that flipped classrooms can make up for the need for time and reduced intrinsic drive that GBL brings with it by using more time and more attention to the individual experiences of the students.

Keywords: Affordance; game-based learning; flipped classroom.

1. Introduction

With the advancement of technology, a lot of technological devices are entering our lives. Electronic blackboard, student tablet computers and other devices into the classroom is to provide innovative possibilities for teaching and learning. Take China as an example, as of 2021, China's compulsory education schools will have achieved a multimedia teacher ratio of over 70 percent and 100 percent Internet access. Among many mediums, games are a modern product that cannot be ignored. According to data from a 2008 survey, almost all boys and girls (>90%) play games, and young people spend an average of 7-10 hours per week playing video games [1]. Since so many people play games, can games be integrated with teaching and learning, and how can they be integrated with classroom teaching? Affordance theory provides a perspective for analyzing these questions.

1.1. Affordance theory's introduction

Affordance theory was first proposed by the famous psychologist Gibson in 1979 in his book The Ecological Approach to Visual Perception. He conceptualizes "affordance" as a relationship, elicited by a particular way in which an actor or group of actors perceives and uses an object [2].Subsequently, scholars in the fields of sociology, communication, and economics have analyzed the meaning of affordance in their respective fields in greater depth and detail. An affordance perspective emphasizes the relationship between individuals and technology. Media identity assumes that the use of technology stems from the intrinsic qualities of the medium. Whereas video game-based learning requires an analysis of the medium used (video games), teaching students is an analysis of the relationship with the person. Using affordance theory to analyze the function of each of the two, the flaws, can be a good way to help us determine whether the two can be matched to produce better learning outcomes.

In fact, a number of scholars have studied game-based learning. For example, Some scholars have given a tentative definition of game-based learning: playing games with explicit learning outcomes [3].And Plass, Homer, and Kinzerhave proposed a model for describing learning using games and analyzed the characteristics that must be present in games that are useful for learning from motivational, cognitive, affective, and sociocultural perspectives[4].Game-based learning environments have been shown to have a positive impact on students' academic performance and

motivation to learn. It has also been suggested that using some of the game's features can prevent students from getting bored with repetitive tasks and thus become more engaged in using intelligent tutoring systems (ITSs) [5]. Most of the games discussed fall into the category of "serious games". They have a greater educational value in their own right, but their integration into the classroom can be a distraction. Although many scholars have made their own studies, how to better integrate game-based learning with school learning, and what kind of games to choose and how to use them more efficiently in teaching are questions that need to be analyzed.

While there are many studies that suggest that games facilitate learning, some scholars have suggested that some features of game-based learning may distract students from immediate instructional goals and reduce short-term learning gains. So we turned our attention to a way of teaching that avoids conflicts between teaching and gaming: the flipped classroom.

Next, we will introduce some features and cases of GBL and flipped classroom respectively and summarize the corresponding affordances and defects. Finally, we compare the affordances of game-based learning and flipped classroom, analyze the superiority of the combination of the two, and make some suggestions for implementing such an instructional approach.

2. The Overview of GBL.

2.1. The definition of GBL

Humans have been playing games since they were very young. Similar behaviors are found in many animals, not just humans. For example, chimpanzees will grow up chasing and playing in the forest, and elephants will make grass vines into grass balls to kick. These behaviors are significant for the physical fitness and emotional mobilization of animals, but are not games with learning outcomes. The game-based learning discussed in this paper is a definition that emphasizes having learning outcomes and is based on video games.

In this case, it is necessary to distinguish between what is gamification and what is game-based learning. One of the hallmarks of gamification is the use of incentive systems similar to those found in games to keep students interested in content that would otherwise be uninteresting to them [5].For example, teachers design activites with rules and give students little red flowers as rewards during instruction and accumulate them to exchange for gifts. In contrast, game-based learning, as discussed in this paper, refers to the use of video games with learning effects in learning, and it’s a kind of teaching models or learning environments based on the connection between games and subject content. Although the definition of game-based learning may vary among scholars, there are many studies that give some characteristics of game-based learning.

2.2. Affordances of GBL

2.2.1. Features

The generalization of game-based features is divided into two aspects, some of which are features of the game design and some of which are features of the effect the game has on the learner. From a game design perspective, Alexiou and Schippers suggests that game design that is motivating to learners needs to include goals, rewards, feedback, and challenges[6].

Snow et al. (2015), summarizing previous research, propose game elements that including performance-contingent incentives (rewarding), personalized agents (choose a game character to represent yourself, such as a monkey), and navigation choices (Students can choose their own locations to explore on the map) [7].

Since affordance theory focuses on the relationship between people and technology, it is also necessary to analyze the impact of GBL on learners. Plass, Homer, Kinzer argue that the main effects of games on learners are motivation, player engagement, adaptivity, and graceful failure[5].Liping Sun et al., on the other hand, based on a synthesis of a large body of literature, suggested four aspects of engagement, motivation, attention, enjoyment as important features of games that produce an

impact on learners[8].Both of these ideas can be summarized as games increase students' interest, participation and engagement, and ease their psychological stress (very enjoyable or not severely punished).These influences of feature of GBL on learners provide a great help in analyzing the affordance of GBL.

2.2.2. Affordances

The first affordance is the sense of engagement. In video game-based learning environment, in addition to the game itself, which may be designed to guide and add elements of player motivation, games are not all about knowledge are more likely to engage students, thus increasing the engagement of students with insufficient prior knowledge. For example, Israel-Fishelson and Gauthier conducted experiments with games in the areas of programming and biology, respectively, and found that students were not only addicted to the rewards they received from the games, but the games themselves were also addictive [8, 9].These offer the possibility for students to devote more time to play. When games focus on learning outcomes, it means students will spend more time outside of class for additional learning. At the same time, for lower-achieving students, the non-knowledge part of the game can be equally experiential and rewarding, which enables all students to engage in learning to some extent, even as a reflection of the idea of inclusive education.

The second affordance is to learn with ease. Learning with ease means that it allows students to relieve anxiety. The affective design within the game may also have an impact on students' emotional experience. This is also very important for students today.

The third affordance is that students can be given more opportunities to solve problems. Some well-designed games always give more complex scenario information as well as challenges that lead students to apply their knowledge to solve problems. Even for games known to the general public (such as World of Warcraft in study), studies have shown no significant difference between their training effects on the brain and the training effects of specifically designed games [10].

But GBL also has some of the same anti-affordance, such as requiring students to spend more time on games. The game design process requires attention to both the subjects to be covered and the desire to have people play. At the same time, some studies have shown that some emotional experiences in games have little meaningful impact on learning, and others have shown that the incentive reduces students' intrinsic motivation [11].So students still need teachers to guide them in the systematic learning of knowledge as well as personal emotional guidance, which requires us to put our eyes back on classroom teaching.

3. The Overview of Flipped Classroom.

3.1. Definition of flipped classroom

The flipped classroom was first proposed by Maureen Lage et al. in a paper, but they did not precisely describe it with those two words. They described the flipped classroom as a shift from what happens in the classroom to what happens outside the classroom [12].They also emphasize that students can use a wider range of media for learning, and that students can decide for themselves which learning methods to use when focusing on the desired learning outcomes. In this model, the key to learning occurring changes from the teacher to the student, creating a student-centered learning environment. Research has already shown that flipped classrooms are more effective in improving student achievement than traditional lecture-based teaching methods [13, 14].This may be related to the peer support atmosphere in the flipped classroom. This atmosphere can actually be achieved through the social affordance of the game. There have also been attempts to use video games to integrate into the flipped classroom. And the tools teachers often use include the video viewing tools include TED, videotaped lectures, documentaries, and so on [15].

3.2. Affordances of flipped classroom

From the above literature and cases, we can summarize that the affordances of Flipped classroom mainly includes: freer learning environment, diverse learning tools, more sufficient learning time, giving students the right to choose, and more attention to students' personal experience. Some articles point out that in order to improve the teaching effect of flipped classroom, it is necessary to choose appropriate teaching tools and adopt appropriate monitoring strategies. Considering the student perspective, some students find it difficult to follow the class or are frustrated (because the flipped classroom is very different from the traditional way of teaching and requires more active learning from students) [16].Other students argue that there is too much pre-class learning tasks [17], and these are all challenges faced in the flipped classroom.

4. Method

This article analyzes a total of 19 articles on GBL, flipped classroom, all of which are the result of searching with the keywords of Game-based learning, video game & education, flipped classroom, and this article is based on the affordance theory to re-analyze these literatures, to extract the advantages and disadvantages of each of Game-based learning, flipped classroom contained in these articles, and to come up with the subsequent analysis process.

5. Analysis of the affordances of Combining GBL and Flipped Classroom

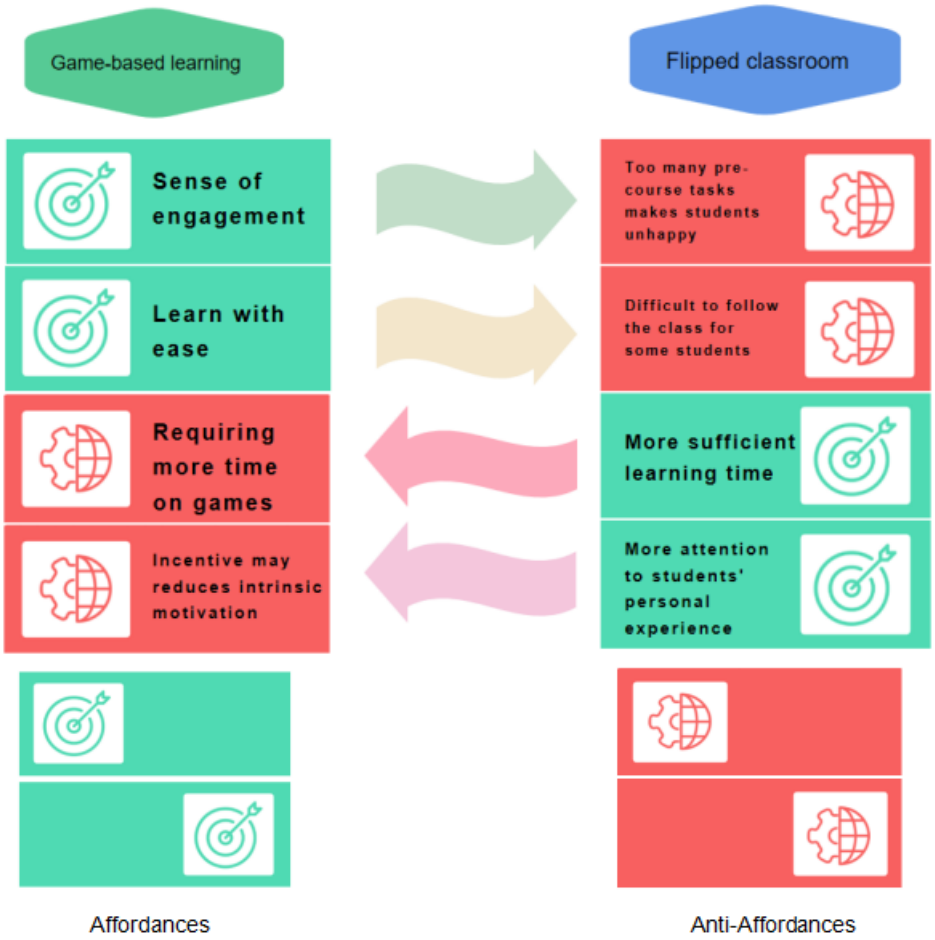


Fig 1. GBL versus flipped classroom affordance.

As can be seen in the comparison above, there is a complementary relationship between the "affordance" and "anti-affordance" of GBL and flipped classrooms. For example, GBL may require students to spend more time on games, and a flipped classroom can provide just enough extra learning

time. In addition, the flipped classroom focuses more on the personal experience of students in the classroom, just in time to address the reduced intrinsic motivation that GBL may bring. And the problems that a flipped classroom may cause students to feel pre-tasked are eliminated by the relaxed and enjoyable feeling that the game has .At the same time, the problem that some students have difficulty in keeping up in the flipped classroom can also be alleviated by GBL's affordance that makes learning easy.

And the problem of tool selection for the flipped classroom is simplified by the use of games. Teachers only need to discover the right game, or part of a game that is appropriate, to teach. Also the lack of systematic learning of knowledge that GBL may cause can be compensated by the additional flipped classroom learning process. Only a few simple adjustments to the teaching process are needed.

6. Case study

Case1. Combining video games with flipped classrooms to learn physics concepts [18].

Table 1. Basic information for case 1.

Groups	Method	Participants
GD(game-discussion) group	Play a video game before instruction	26(12 male,14 female)
GI(game-instruction) group	Play the commercial video game and participate in the same learning as TI	25(11 male,14 female)
TI(traditional instruction) group	Participate in a standard classroom	26(13 male, 13 female)
Game	Ballance	Angry birds
Content/Subject	Laws of motion	Conservation of mechanical energy
Conclusion	GD and GI groups performed better than the TI group in the pre-test, and the overall results were better for the GD and GI groups than for the TI group,indicating that the combination of video games and flipped classroom is better than the traditional teaching mode.	

In this case, the experimenter selected 77 subjects to learn Newton's laws of motion and conservation of mechanical energy together. In this case, the subjects were divided into three groups, learning to play a commercial video game before class while receiving classroom lecture-based instruction (GI);playing commercial video games prior to lectures and learning in the classroom in the form of independent group discussions and exercises(GD); and lecture-style teaching (TI); respectively. Finally, it was verified that both the GD and GI groups learned better than the TI group, and there was not much difference in learning outcomes between the GD and GI groups. In which the participatory and relaxing effect of the video game has a great role in the increase of students' motivation, and the students can have more personal experience when the game is played before the class and the learning is done during the class.

Case2. Combining Video Games with Flipped Classrooms to Learn Chemistry Labs [19].

Table 2. Basic information for case 2.

Groups	Method	Participants
Mini-game-based flipped classroom group(MGFC)	2–3 students play the game called Distillation together	31
Video-based learning flipped classroom group (VLFC)	Students watch a traditional chemistry distillation experiment video and they can control the progress of the video and discuss in groups	32
Content/Subject	Chemistry	
Conclusion	Students in the MGFC group learn better than the VLFC group in terms of recognizing the device, assembling the device, and carrying out the process of the distillation operation.	

In this case, a total of 63 first graders participated in the experiment. Participants are divided into two groups, MGFC and VLFC. It was verified that after the video game, the students performed better than the VLFC group in the identification of chemistry lab tools and distillation operations. In this case, the flipped classroom provided more time for games, which are more likely to stimulate children's interest and thus improve performance through engagement and easy learning.

7. Conclusion

As shown in the conclusions of the two cases above, Case 1 demonstrates that a flipped classroom instructional model using video games or videos is unique in improving student academic performance. The reason for this is that, on the one hand, flipped classroom pays more attention to the learning experience of individual students and reduces the passive learning of students in the traditional lecture method, and on the other hand, compared with the pure classroom teaching, students spend more time studying before class, and these two reasons are what make the flipped classroom more efficient than the traditional teaching. Case 2, on the other hand, proves that the use of video games for flipped classroom instruction (MGFC group in the case) has better results in improving students' pre-testing and partial memorization skills. This case is a good comparison of the difference between the effectiveness of flipped teaching using videos and using games. In teaching with games, games give students a sense of participation that is far from being achieved by simply watching videos, while playing games avoids excessive learning pressure before class, and in the case study, teaching in small cooperative groups also better alleviates the problem of students feeling difficult to follow the teacher if they are using flipped classroom.

What can’t be ignored is that games that provide learning outputs are not easy to find due to good design. Teachers need to use these games to provide a better overview of learning, to help students summarize knowledge in the classroom, and to work on self-monitoring skills, like let students ask themselves "What am I really playing? What is the knowledge designed into it?" In this way, we can maximize the effect of the combination of games and flipped classroom.

Meanwhile, through the affordance theory, it is further verified that the use of video games as a teaching tool for flipped classroom has a special effect, and it can complement the strengths and weaknesses of flipped classroom at some levels, which provides some directions to be explored in the subsequent empirical research.

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