STUDENTS' PERCEPTIONS OF GAME-BASED LEARNING USING CODINGAME

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Abstract

Game-based learning incorporates educational content into computer games. It is a trend with many advocates and one which has experienced rapid growth in recent years. This paper discusses the potential of this approach and presents the results of the author's pilot study of the perceptions of students towards game-based learning in introductory computer programming. Data was collected from 33 first-year undergraduate students using a survey consisting of 16 Likert data items and using a 5 point Likert rating scale. The findings indicate that the students found this particular approach to learning enjoyable and in some cases preferable to conventional approaches.

Keywords: Game-based learning, serious games, CodinGame, student engagement

Introduction

General purpose computers in their modern manifestation entered classrooms in the early 1980s with educators keen to explore their potential in supporting part of the curriculum. In a short space time they gained many advocates who were quick to recognise their significance in promoting the development of higher order thinking skills and independent learning. Papert (1980), for example, was influential in arguing that students should learn computer programming as a means of developing such skills. He observed, “Children who had learned to program computers could use very concrete computer models to think about thinking and to learn about learning” (Papert, 1980, p. 11). While many researchers claimed that computer programming could support the development of problem-solving skills, Mayer (1988) argued that these claims were not strongly supported by research. On the contrary, research suggested that students struggled with understanding the fundamentals of computer programming, impacting their motivation for learning.

To address these challenges, educators began exploring alternative approaches to motivating and engaging students. By the 1990s, computer gaming technology had grown rapidly, and educators began to recognise its ability to motivate and engage players and were keen to tap into this potential. They began adopting the use of off-the-shelf games into their teaching practice, leading some to coin the term *edutainment*. Despite some success, it quickly became apparent that simply utilising games in teaching did not necessarily result in a more engaging learning experience. Where too much emphasis was placed on the game, the learning outcomes became obfuscated, and where too much focus was placed on the learning content, the motivational benefits of the game were reduced. By the end of the 1990s, researchers had recognised that whilst games have the potential to be effective pedagogical devices, those often used for educational purposes were not based on solid educational principles and practices

(Gunter, Kenny, & Vick, 2006). This led researchers to explore how to design games based on well-established educational principles with numerous frameworks developed in past decade dedicated to the design of such (serious) educational games (Garris, Ahlers, & Driskell, 2002; de Freitas, S. & Jarvis, 2007; Butt & Wills, 2015). This game-based approach to learning has been popular in recent years particularly at the primary and secondary level of school education. Whilst a majority of the students have had experience of playing computer games, the utilisation of games-based learning in higher education remains under explored. For instance, introductory computer programming courses remain a challenge for students in higher education (Woodley & Kamin, 2007). They have for some time been identified as suitable candidates for games-based learning yet the adoption of games in this area remains limited. Various reasons have been suggested by previous studies including the effect of students' perceptions of the game on their learning experience. Thus, investigating students' perceptions of game-based learning is a necessary precursor to adopting such an approach in introductory computer programming courses.

Methodology

The study utilised an existing web-based serious game known as CodinGame. This is a recent challenge-based learning platform created in 2015 that supports multiple programming languages including Java, Python and C++. The CodinGame graphical user interface presents learners with a traditional code editor integrated with a game-like visualisation as shown in Figure 1. The learner attempts to complete code challenges, and the system responds by executing the actions in the game.

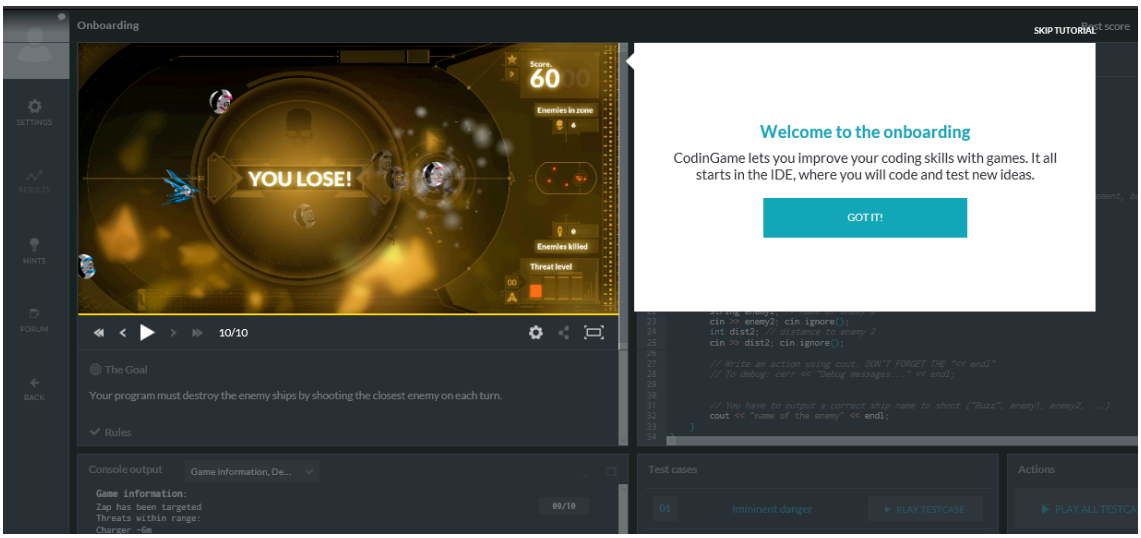

Figure 1. The CodinGame Graphical User Interface.

The study was conducted at Southampton Solent University during the academic 2015-2016, and a total of 33 participants took part in the study. All of the participants were first-year undergraduate students who had completed at least one term of a computing or software engineering course. The participants were mainly young male UK students and native English speakers as summarised in Table 1.

Table 1

Demographics of Participants

Demographic	Variables	N (%)
Age	18-20	29 *(87.88)*
	21-29	2 *(6.06)*
	30-39	2 *(6.06)*
Gender	Male	32 *(96.97)*
	Female	1 *(3.03)*
Ethnicity	White / White British	22 *(66.67)*
	Mixed / Multiple Ethnic Groups	2 *(6.06)*
	Asian / Asian British	2 *(6.06)*
	Black / African / Caribbean / Black British	5 *(15.15)*
	Other	2 *(6.06)*
Student Status	UK Student	26 *(78.79)*
	European Student	6 *(18.18)*
	Other International Student	1 *(3.03)*
English Native Speaker	Yes	22 *(66.67)*
	No	11 *(33.33)*
Degree	Computing	23 *(69.70)*
	Software Engineering	10 *(30.30)*

Each participant first completed a tutorial that helped familiarise the participant with the CodinGame graphical user interface. The participants were then asked to solve between 3 – 5 challenges depending on their progress in the CodinGame within a period of 90 minutes. Following the activity, an instrument in the form of an online survey was utilised to capture the responses of the participants. The survey consisted of 16 Likert data items and 3 constructs, namely, attitudes, experience and expectations. The questions were based on the work of Ibrahim, Yusoff, Mohamed, and Jaafar (2011). Each participant was asked to complete the survey by rating each item on a five-point rating scale ranging from 1 = strongly disagree to 5 = strongly agree. The survey also included a single open-ended question to elicit a qualitative response. To prevent incomplete responses, the survey questionnaire required a participant to fully complete all the questions before being able to submit their responses.

Results and Interpretation

Table 2 shows the responses of the participants to items organised under the construct *attitudes*. A key finding for this construct is that a majority (67%) of the participants enjoy studying, and (60%) do not find the course boring, suggesting that the participants are generally motivated students.

Table 2

Attitudes of Participants

Item	Number of Participants				
	Strongly Disagree	**Disagree**	**Neither**	**Agree**	**Strongly Agree**
I like studying	0	1	10	12	10
I get good marks at University	0	1	14	14	4
I often find my course boring	8	12	11	2	0
I learn better by myself	3	11	10	8	1
I like to play video games	1	0	6	5	21
I am good at playing video games	0	0	7	12	14
I think video games are educational	1	3	9	12	8

However, a fewer number of students (55%) felt that they got good marks at university, suggesting some disparity (9%) between the motivation and performance of the participants. Interestingly, a majority (79%) of the participants like playing video games, (79%) believe that they are good at playing video games, and (61%) perceive video games to be educational. This suggests that the participants are generally receptive to the idea of a games-based approach to learning.

Table 3 shows the responses of the participants to items categorised under the construct *experience*. The responses indicate the perceptions of the participants on their experience of using CodinGame. The majority (76%) of the participants found the games-based approach to learning to be helpful, (73%) interesting as well as (82%) challenging. Only 3% of the participants indicated that they found it unhelpful or not challenging. It can therefore be inferred from these results that the participants generally had a challenging but positive experience of a games-based approach to learning as provided by CodinGame.

Table 3

Participants' Experience of CodinGame

Item	Number of Participants				
I found solving the given problems really interesting	1	1	7	12	12
The games helped me to think critically	2	2	11	13	5
The games challenged my understanding of the subject	2	0	4	14	13
I think that video games based learning is helpful to me	1	2	5	17	8

Table 4 indicates the expectations of the participants after experiencing a games-based

approach to learning using CodinGame. Whilst a large majority (76%) of the participants felt it was worth using games for learning, and a similar number (73%) would like more opportunities to learn using games, fewer participants (58%) showed a preference for games-based learning in comparison to more traditional methods in class.

Table 4

Expectations of Participants

Item	Number of Participants				
I prefer completing exercises in video games to multiple choice questions in class	1	1	13	8	10
I prefer using games to learn compared to traditional methods in class	3	1	10	11	8
It is worth using games for learning in the future	1	2	5	13	12
I would like more opportunities to learn using games	0	2	7	13	11
I would like to learn all computer subjects using educational games	5	7	9	7	5

Furthermore, the participants were split as to whether or not they would like to use a games-based learning approach in all their computer subjects, with 36% indicating they would and as many indicating they would not. Despite perceiving games-based learning as a worthy endeavour the participants are not entirely convinced that it can substitute traditional approaches in class or should be used in all computer subjects.

Table 5 provides a qualitative summary of some of the responses of the participants to the open-ended question: *overall what do you think about game-based learning?* The responses indicate that a variety of factors influence the participants' perceptions towards game-based learning. Amongst the 33 comments, 25 of the comments indicated a preference for game-based learning, 3 indicated a preference for traditional methods whilst the remaining 5 indicated no preference.

Table 5

Sample Set of Responses to Open-ended Question

Participant	Comment
1, 2	Good
3	Great for skills such as logic and problem solving
6	fun factor is important to me, just because it’s a game doesn't mean its enjoyable
7	I prefer other methods
12	It is really useful and a lot of fun, but it is not applicable for every lesson. Sometimes it needs to be taught in traditional way
15	Fun and can see code in action instead of output text
20	It's a fun approach towards coding and programming which can seem quite plain, however bringing games into it adds color into it which can stimulate the mind a bit

Participant	Comment
	more than usual.
33	Good to add another perspective of learning, although I feel it couldn't replace a well- educated, passionate lecturer.

Table 6 shows the outcome of a thematic analysis of the responses.

Table 6

Thematic Analysis of Responses to Open-ended Question

Theme	Sub-theme	Participant
Critical thinking	Critical thinking Problem solving	8, 25 3, 22, 23, 25
Gameplay	Challenge Feedback Support Fun Progression	29, 31 10, 15, 32 21, 26, 33 6, 11, 12, 14, 15, 17, 18, 20, 23, 24, 27, 30 26, 32
Game-world presentation	Visualisation Interaction	4, 5, 10, 15, 20, 28, 32 16

A total of 27 of the 33 responses showed interesting features that resulted in 3 themes and 9 sub-themes. Amongst the responses, 15% of participants commented on how the game-based approach to learning helped develop critical thinking and problem solving skills whilst a majority (58%) of the participants commented on some aspect of the gameplay. Fun was a particularly important facet of the gameplay for 36% of the participants as was the visualisation for 21% of the participants.

Discussion

This paper detailed the results of a pilot study investigating the perceptions of students towards game-based learning. Prior to this study each participant had completed the *Introduction to Programming and Problem Solving* unit using Python. CodinGame was utilised as the platform for game-based learning. This was selected over designing a bespoke game due to time constraints. Furthermore, it was preferred to other existing games such as Scratch and CodeCombat, which are mainly used in schools and hide away code complexity and other useful details.

The perceptions of first-year undergraduate software engineering and computing students were captured using a survey designed with 16 Likert data items with a 5 point Likert rating scale and 1 open-ended question to elicit qualitative responses.

The results of this pilot study indicate that most of the students found a game-based approach to learning worth exploring and were interested in further opportunities to use this approach. This suggests that the students are receptive to such an approach to learning. However, fewer students were convinced that this approach could substitute

other more conventional approaches. Perhaps a combination of a game-based approach supported by conventional techniques may provide a better learning experience for the students. Whilst the results are encouraging, a larger study over a longer duration with an extended question pool and perhaps supported with a bespoke game could strengthen the understanding for the adoption of this approach.

Some limitations of this study include the small sample size which has implications for the statistically reliability of the conclusions that can be drawn. Additionally, the survey relies solely on the students' perceptions of their performance using the game-based approach to learning. An empirical approach would provide greater insight on the impact of game-based learning on the students.

Conclusion

This paper investigated the perceptions of students on game-based learning. This study found that students were receptive to such an approach and favoured greater opportunities to experience it when learning computer programming. Most of the students found the experience enjoyable whilst some students found it preferable to conventional approaches. The overall results suggest that perhaps a game-based approach complemented with conventional techniques may be worth exploring.

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