Digital game based learning for supporting undergraduate students' learning of engineering in 3 different universities

Richard Joiner
Department of Psychology
University of Bath
Bath
r.joiner@bath.ac.uk

Jos Darling
Department of Mechanical Engineering
University of Bath
Bath
j.darling@bath.ac.uk

Ben Drew
Department of Design, Engineering & Mathematics,
University of the West of England
Bristol
Benjamin.Drew@uwe.ac.uk

Ya Huang
Department of Mechanical and Design Engineering,
University of Portsmouth
Portsmouth
Ya.Huang@port.ac.uk

Abstract

Digital games have been proposed as an innovative method in STEM teaching and learning, however there has been very little research which has evaluated the use of Digital games in STEM education. The aim of this presentation is to discuss the evaluation of Racing Academy for supporting undergraduate students learning of engineering in three different universities. Racing Academy is a digital game that is specifically designed as a way to engage and motivate students in engineering. It achieves this by engaging them in tasks that were authentic, that involve real practice and through which they can see the effects of their choices, interventions and actions. The players had to handle and analyse multiple and multimodal data sources to make considered choices, to reflect on and review their interventions and actions and to collaborate with others and play the game itself. It was used by 329 students from 3 different universities as part of their first year undergraduate engineering course. The project found that after playing Racing Academy there was an increase in students' knowledge and understanding in all three of the courses. They found it motivating to play, but there were large differences between the three universities in terms of the students' motivation towards using Racing Academy. In conclusion Racing Academy did successfully support learning in engineering. It provides an example of how digital game based learning can support learning in higher education, however the way the game is embedded in a course impacts on the potential benefits.

Keywords
Digital Games, Engineering, Undergraduate students

1. Introduction

The UK has recently stressed the importance of science, technology, engineering and mathematics (STEM) for their long term economic futures (DfEL, 2009) and the need to improve STEM education. In pursuit of this aim, there has been considerable interest in the use of digital games for supporting STEM education. There are a number of important reasons for this interest in using digital games in STEM education. First, a number of reports have shown that digital games have become an integral part of life for children and adolescents. In a recent survey of US adolescents, 98% of teenagers played digital games (Lenhert, Kahne, Middaugh, Macgill, Evans & Vitak, 2008) regularly at least once a week. Second, well designed digital games can provide powerful learning environments (Gee, 2003, 2005) and have the potential of placing students in simulated environments where they face authentic, open ended challenges similar to those faced by actual professionals. Gee (2003, 2005) argues that when individuals play these type of digital games they experience first hand how members of a profession think, behave and solve problems, thus they are engaged in a deep, meaningful learning experience. Shaffer et al., (2005) argue that too much of classroom learning is about understanding symbols divorced from the concrete reality of those symbols. In the virtual worlds of games learners experience the concrete realities of what those words and symbols represent. They can understand complex concepts without losing the connection between the abstract ideas and the real problems they can be used to solve. Shaffer et al., (2005) conclude that one reason computer games are powerful learning environments is because they make it possible to develop situated understanding.

Recent research appears to confirm the benefits of digital games for supporting situated learning. Coller & Scott (2009) developed a racing car game which they used to support students learning of numerical methods in an undergraduate mechanical engineering course. They found that students taking the game based course spend roughly twice as much time, outside of class, on their course work. They showed greater depth of understanding of the relationship between concepts and they were very interested in a further follow up course. We have also found that using a digital game facilitated undergraduate students' learning of engineering (Joiner et al., 2011).

The aim of this paper is to further investigate the use of a digital game, called Racing Academy, to support undergraduate students' learning of engineering in 3 different Universities.

2. Racing Academy

Racing academy is based on a real-time vehicle dynamics simulation system, which is capable of recreating the experience of driving any automobile. It accurately models in real-time how cars behave and react. The games engine has the capacity to allow users to manipulate the engineering parameters of their vehicles. (such as the engine, transmission, tyres and suspension) in order to optimize vehicle performance and get a better understanding of the

system dynamics that influence behaviour. Players must engage with the underlying physics and work as a member of a team where practice arises out of real physics and involves the social negotiation of understanding.

The game has three levels and a race level. In the first three levels, players race a computer controlled opponent ("the AI driver") along a quarter mile drag strip (see Figure 1). Every time they beat the AI driver they move on to the next level and the races typically last between 11-15 seconds.

Figure 1: Drag Strip

In level 1 the player is given the choice of changing the controls, changing the colour of the car and a choice of one of six engines. In level 2 the players have a choice of tyres and in level 3 the players can change the gear ratios. Racing Academy can be downloaded free from the following website

http://www.lateralvisions.com/Racing_Academy/JISC_Prototype.aspx

3. Evaluation of Racing Academy in 3 Universities

Racing Academy was used to support first year courses in mechanical engineering at the University of Bath (140 males and 26 females), at the University of Portsmouth (75 males and 5 females) and at the University of the West of England (72 males and 10 females). It was used as part of the students' course and they were organized into racing teams consisting of 3 to 5 students. The teams designed a racing car in Racing Academy which was used to compete in the drag race for the best time. The project lasted two weeks and at the

end of two weeks there was a grand final where the teams raced against each other and there was a prize for the winning team.

We evaluated Racing Academy by asking the students to complete a questionnaire a week after they had finished using Racing Academy. They were first asked how frequently they played racing academy and on average, the students were playing several times a week. We assessed how motivating students found Racing Academy by using the following four scales: (i) how much they enjoyed playing Racing Academy, (ii) how good they were at playing Racing Academy, (iii) how much effort they put into playing Racing Academy and (iv) how valuable playing Racing Academy was.

	Bath		Portsmouth		UWE	
	M	SD	M	SD	M	SD
Comp	3.4	0.9	3.6	0.5	3.5	0.6
Enjoy	3.5	0.7	3.6	0.6	3.2	0.8
Value	3.2	0.7	3.6	0.7	2.9	0.9
Effort	3.4	0.6	3.8	0.6	3.3	0.6

Table 1: Racing Academy and Motivation

There were a number of differences between the three courses concerning how motivating Racing Academy was to play (see table 1). There was a significant difference in terms of how much they enjoyed the game, $F(2,324) = 8.0$, $p < 0.05$. Students at Portsmouth enjoyed playing the game more than students at the other two Universities. There was also a significant difference in terms of how much effort the students put into playing the game, $F(2,324) = 5.0$, $p < 0.05$. Students at Portsmouth reported putting more effort into playing the game than students at the other two Universities. Finally there was a significant difference in terms of how valuable the game was for their course work, $F(2,324) = 19.0$, $p < 0.05$. Once more students at Portsmouth reported putting more effort into the game than students at the other two Universities. There was no difference in terms of how competent they felt playing the game, $F(2,324) = 1.7$, $p > 0.05$.

Another measure of the impact of Racing Academy on students learning is how successful they felt Racing Academy was in supporting their learning. We measured this by asking the students the following question 'Racing Academy was specifically designed to support your learning on your course. Do you think it was successful? Table 2 shows that most students thought the game was quite successful or a little bit successful at supporting their learning on their course. There was also a significant difference between the three Universities in terms of how successful the course was in supporting their learning. Students at Bath and Portsmouth thought it was more successful at supporting their learning than students at UWE, $F(2,324) = 5.9$, $p < 0.05$.

Successful	Bath		Port		UWE	
	N	%	N	%	N	%
Not at all	0	.0%	0	.0%	9	11.5%
A little bit	37	23.0%	17	21.5%	27	34.6%
Quite	99	61.5%	49	62.0%	37	47.4%
Very	25	15.5%	13	16.5%	5	6.4%

Table 2: Perceived success of Racing Academy

4. Conclusion

Therefore in conclusion, Racing Academy was successfully implemented to support first year undergraduate students learning of engineering.. They found it motivating to play, but there were significant differences between the three universities in terms of the students' motivation towards using Racing Academy. In conclusion Racing Academy did successfully support learning in engineering. It provides an example of how digital game based learning can support learning in higher education, however the way the game is embedded in a course impacts on the potential benefits.

5. References

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