A Computer-based Educational Adventure Challenging Children to Interact with the Natural Environment Through Physical Exploration and Experimentation

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Abstract: The researchers' paper discusses the development of a computer-based educational game which challenges children to interact with the natural environment through physical exploration and experimentation. The researchers' project seeks to counteract the negative behaviours associated with excessive computer game play amongst children 8 to 12 years old. By leveraging the positive learning outcomes that can be achieved through computer gaming and combining these with outdoor learning strategies, *Jumping the Fence* encourages children to take responsibility for surveying and caring for a local ecosystem. The game requires children to reflect critically on their computer use, become more physically active, gain social skills and develop an affinity towards nature. Educators are able to adapt the game to their school's own curriculum and thereby provide an alternative learning strategy that encourages physical and social engagement.

1 INTRODUCTION

The potential benefits of computer games in education, training and entertainment are widely appreciated, but their downside is also equally a matter of concern. Whilst computer games are mostly played for recreational purposes, or to keep the player in suspense, the frequency of game playing and the average duration of the games we now engage in often bring about unintended consequences. On the other hand, not everything about playing computer games is bad. Computer Based Learning (CBL) has great promise as an instructional tool and, whether we like it or not, proficiency with computers has become a key part of the skill set required by modern children, and familiarity with interactive technologies is essential for success in contemporary society.

The question that concerned the researchers was: how can we balance the benefits of CBL and computer literacy with the disadvantages of spending large amounts of time in front of a computer? Would it be possible to design a computer based learning game that actually required students to get up from their seats and move around in their nearby environment in order to engage with and advance in the game? In order to answer to these questions, the idea of creating an educational game called *Jumping the Fence* (*JTF*) was born. The game has been proven to be successful in providing alternative learning strategies that encouraged students in physical and social engagement.

The paper covers the methodology, the design and construction of the game, the observations made during the testing phases and end with a discussion on the outcomes of the research project and by finally providing some suggestions for future research.

2 LITERATURE REVIEW

The literature review revealed quite early in the study that computer based simulations mirroring real life examples combined with a good narrative are known to be highly effective in developing an understanding of complex systems (Wastiau, Kearney and Van den Berghe, 2010; Barab, 2009;

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De Freitas and Neumann, 2009; Royle, 2009; Salen and Zimmerman, 2004; Dziorny, 2003; Garris, 2002; Klaila, 2001; Prensky, 2001). It also became clear that such strategies could be readily applied to developing real time educationally focused games that address complex environmental and scientific issues and that outdoor learning was a tried and tested educational strategy well suited to support this area of learning (Young et al., 2012; Knoll, 2011; Nichol et al., 2007; Cooper, 2006; Dillon et al., 2005; Leger, 2003; Lund, 2002; Neill, 2002; Fjortoft, 2000; Lappin, 2000; Moore and Wong, 1997). For these reasons, the study was designed to find out whether or not the idea behind the *Jumping the Fence* educational game would work in practice and whether the gaming and learning strategies developed might be refined for further use in other areas of education. Furthermore, it became apparent that if such an idea was successful, such a game might encourage users to reflect critically on their daily computer use and provide educators with a healthy educational alternative to the current classroom based approach to computer based learning activities. The questions arising from the literature review resulted in the formulation of the following two guiding questions:

- Can a computer based educational game be developed that encourages young people to physically interact with the natural environment?
- What interpersonal strategies might be identified that would help achieve these outcomes?

3 METHODOLOGY

The *Jumping the Fence* project utilises design-based research as its primary methodology, since this approach allows for the carrying out of both design and testing in the context of real-life settings (Barab et. al 2005 p.91). Although normally considered to be a methodology primarily associated with educational practice, the iterative nature of design-based educational research aligns directly with the working methods used extensively in both creative arts practice and throughout the design professions. The use of an educational, design-based research methodology allowed the author to create an initial application which could then be used as a test vehicle, from which outcomes could be used to improve the application in an iterative process—as is typically done in most design related research. According to Barab and Squire (2004) "design-based research involves introducing innovations into the booming, buzzing confusion of real-world practice (as opposed to constrained laboratory contexts) and examining the impact of those designs on the learning process" (Barab and Squire 2004 p.4). From such testing the "lessons learned are then cycled back into the next iteration of the design innovation" (Barab, 2005 p.92). This iterative approach to design allows for unexpected or unpredicted events and outcomes identified during test trials to be accommodated into the design process and future outcomes. In this way, the researchers could be open minded to surprises and react appropriately by adjusting the design of the application to cater for the needs of the research subjects and the environment where the test takes place. To gain a better understanding of how teachers and students were responding to the design and functioning of the game, the researcher relied primarily on the gathering and analysis of both quantitative and qualitative data, which in turn determined the evolving technical structure of the game mechanics and game story. Throughout the testing of the game, student and teacher interaction with the game, as well as the learning outcomes were measured by practically assessing the student's acquired knowledge, reactions and experiences in four ways—via oral assessment (interviews with students and staff before and after playing the game); by questionnaires at set intervals during the study; by confidential feedback from teachers based on course assessment and subsequent classroom observations and, lastly, by observation in the field (video recording how students and teachers acted and interacted and documenting a range of associated activities, such as what students observed and wrote about in their field diaries). In particular, teacher and student feedback and interviews later proved to be a valuable source of evidence that clarified many of the activities and interactions that were evident in videotaped field recordings.

4 THE GAME

The aim was the design and production of an alternative form of computer game, which seeks to blend the benefits of computer based educational gaming with a range of strategies that encourage the gamer (and student) to move beyond the restrictions of the computer and the classroom and engage directly with the natural environment—in the process forming research groups, developing social skills and taking part in a range of low-impact, outdoor physical activities. In the playing of the game, it is hoped that the student gamers will learn

about Australian native wildlife, science, the environment and sustainability issues and—above all— they might have fun in the process. The practical development of the first trial version of the *Jumping the Fence* game was based on a preliminary study designed to identify a suitable area of study to which the researcher's project and ideas could be applied and tested. It was decided to structure the game and its educational outcomes, its visual design and language, as well as the levels of computer literacy required to play it so as to be relevant to Australian Year 5–7 students engaged in the standard Queensland primary school curriculum. The children in the sample that volunteered to participate in the study were typically between 9 and 12 years of age and were drawn from two composite year classes (grades 5-6 and grades 6-7)—which accounts for the wider than might be expected age range for such a trial. Since the primary aim of the *JTF* game was to encourage students to engage with outdoor learning and physical activities and, in the process develop an understanding of environmental and sustainability issues, as well as knowledge of Australian wildlife, plants and habitat were identified as being most relevant to the author's project. When students were asked about their favourite non computer games, the following topped the list: *Lego*, swimming, dancing, camping, bike riding, cops and robbers (and other chasing games), supervised team sports activities and some board games, in particular *Dungeons and Dragons* and *War Hammer*. Most students were familiar with Chess and some had seen Backgammon, but these were more often played by parents or older relatives. That so many children were familiar with *Dungeons and Dragons* and the concept of role playing games (possibly because the game would have been played by their parents as teenagers and then by them with their children) suggested to the authors that adapting the principles of role playing games might not be as problematical as first thought. Since these games are typically overseen by a Game Master, who controls and delivers the story, the role of the teacher—as guide, administrator, content developer and arbitrator— could also be easily accommodated. In the same way that these games break up their world into a series of grids and tiles, breaking up the *JTF* game in small sections which interact to form a larger picture therefore became an obvious design and playing strategy. Requiring students to accurately measure and survey their outdoor "research" area and turn it into a 2 by 2 meter grid encompassing an area 8 metres by 6 metres then map this area into the computer—along with making a detailed analysis of the plants and animals that live in each square, requires students to apply skills in maths, geometry, drawing, writing and teamwork as well as observational and communication skills. Children must think spatially and learn how to turn their complex three dimensional real world area into a simple two dimensional map that uses colours and legends for representation. At the same time the players are creating the very grid on which the game will be constructed and subsequently played.

The narrative was created to encapsulate as many of the ELs outcomes for the Year 5 and Year 7 Key Learning Areas (SOSE, Science and Health and Physical Education) as possible, with the view to adding and refining them as the project moved forward. The protagonist of the game is a young female kangaroo who goes by the name of Kangi. Kangi is a very up to date kangaroo who spends a lot of her time in the wilderness of Australia, but who often comes into cities and towns to study humans and learn their ways. Kangi has many magical qualities, including the ability to speak to children and use a variety of modern communications tools (without having to pay for them!). Her mission is to explain to students just how vulnerable the Australian natural environment is and help them understand how they can help protect it and her friends (Figure 1). Importantly, Kangi needs the children's help to not only save the local plants and animals, but to provide information for her friends back home, who are missing their relatives and friends.

Figure 1: Kangi and her friends explaining how an eco system works.

In summary *JTF*'s model of teaching and learning is a semi-closed circuit model (Figure 2), where the research and learning starts in class by playing the introductory levels of the game on the school workstations. Students can work individually or in their teams at the initial stage, but as students are assigned their roles, each student moves to their own

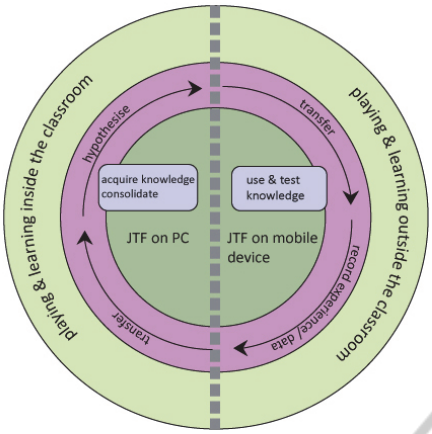

Figure 2: Semi-closed circuit model (indoors>outdoors>indoors...).

computer the focus on the learning tasks associated with their task in the game. Each indoor and outdoor task is assigned by the game master or game system, but input from external sources (student research, new knowledge from guest speakers, the internat.) can also be entered into the system (Figure 3).

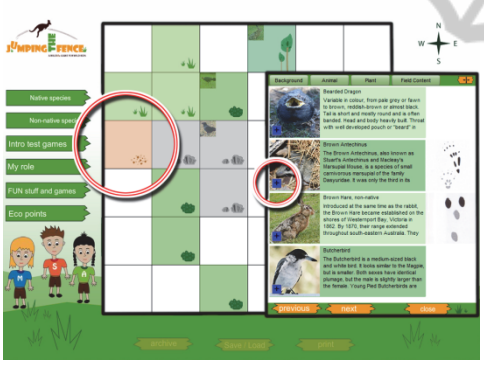

Figure 3: Students placing content into the computer based game interface.

5 TESTING

The testing and development of *JTF* was done with the co-operation of the teachers and students of Sunshine Beach Primary School, on the Sunshine Coast in South East Queensland between October 2008 and July 2010. The first study group consisted of 12 primary school students aged between 8 and 10 years old and the second study group consisted of 25 primary school students of the same age group. Students in both group were identified by the teachers as suffering from Attention Deficit Hyperactivity Disorder (ADHD) but were not identified individually. The first study was divided into two parts. In the first visit, the students were asked to fill in a questionnaire that helped the researchers to build a profile of the students so that the researchers could develop and customise the initial game concept on the basis of the student's preferences and the identified requirements of the teachers and the curriculum. The second part of the study allowed the researcher to test the initial game prototype with the students, gain feedback and make appropriate improvements. The outcomes of the trials were interpreted and discussed with the students and teachers and these revised findings informed subsequent changes to the game prototype. The findings and observations made during this stage of the study are discussed in the first part of this chapter. The purpose of the second study was to test and refine the computer based prototype within the school setting. As before, after each trial the students were asked to fill in a feedback questionnaire and the results were discussed with the students and teachers and then used to further improve the prototype. The findings and observations from both sets of studies were then used to ascertain to what extent the game fulfilled the researchers' initial proposals and research topic.

5.1 Findings of the Game Trials

The results of both test trials suggested that the idea behind the *Jumping the Fence* game is valid and that it is possible to design a computer based learning game that requires students to leave the classroom and spend more time outdoors engaging with the natural environment. It is also relatively easy to encourage students / players to take on the role of active researchers rather than passive observers, given that many are already familiar with role playing games based on their existing experiences of computer games. In taking on their roles, the students clearly developed an understanding of what a biotype is (even though very few of them were aware of most of the correct terminologies) and, in so doing, most developed a sense of responsibility for, and personal connection with, their research areas. Overall, students indicated there was a high level of pleasure associated with playing *JTF*-both parts-the computer based indoor activities and outdoor based non-computer based activities). To the authors, perhaps the two things that came across most strongly from both groups were the enjoyment and pleasure of being outside away from the constraints of the classroom, and the sense of attachment the students clearly developed for the area used in the study. Giving students custodianship

and a duty of care for their study area is an important part of the *JTF* game strategy, as it requires the application of physical effort as well as the utilisation of appropriate knowledge. Many children by this age have already developed an appreciation for nature and it is therefore relatively easy to encourage most children to become involved in *JTFs* activities. However, an unexpected outcome of the second study was the number of students (8/24) who specifically identified themselves as not liking being outdoors or who found the experience stressful. Responses such as "I like to stay inside'" "Because outside is nil," "It is no fun being outside" and "Because I get headaches outside," were quite unexpected. Although it is perfectly normal for some children to prefer being indoors, it seems that having one third of the students so actively not liking being outdoors is either an aberration or is an indication that changing trends in society may be influencing this outcome. There is a lot of anecdotal evidence suggesting that contemporary children are leading much more protected lives than in the past and those current concerns over "stranger danger" and health and safety issues are bringing about a culture in which children are over protected both at home and at school. It would certainly be unfortunate if this is indeed indicative of a long term trend, although it would be interesting to see whether playing *JTF* over a longer period might change the attitude of some of these students to being outdoors. The students were also very concerned that their biotope would not survive after they left the school (in follow up discussions it seemed to be understood that they would continue to care for the area in their own time after the project was finished) unless arrangements were made to have other students look after it in the future. Several students proposed that responsibility should be passed on to younger students and one student argued that it needed to be someone who could be trusted in the long term, a statement which demonstrates not only how closely the students had become attached to their study area, but an awareness of the longer term needs of the environment they had nurtured. At the 2010 trial, the majority of students thought that it would be advantageous to use mobile devices such as smart phones and tablet computers to play *JTF* and that a mobile device would enhance the game by providing instant access information in the field. Several students suggested that the entire game should be ported to a mobile format for this reason (and also because it meant spending more time outdoors). The students noted that it would be easier to get information directly from the Internet in the course of the game play; but many students argued that mobile devices would not only speed up the game play, they would enable them to stay outdoors all the time. It was quite clear from both written student feedback and follow up discussions that being outdoors and away from the classroom was a major attraction of playing *JTF*. In both field observations and follow up discussions with the teachers it was noted that after only a short time outdoors, the classes were significantly calmer and quieter than they were observed to be when working in the classroom. One teacher later suggested that by the end of the trial it was as if he had different students in the class, since the group as a whole was generally much more collected and better disciplined—in particular the ADHD students, for whom the physical demands of the game proved especially beneficial.

6 LIMITATIONS AND FUTURE RESEARCH

The data and findings described derive from only two small-scale studies, with samples consisting both times of the equivalent of just one class (although students in the first trial were from different class groups and largely did not know each other, as opposed to the second trial where all students were classmates). Nevertheless, the limited number of students will have influenced the validity of the study results to some degree. For this reason, it is suggested that further studies be undertaken with larger sample groups. The benefits associated with outdoor education are well documented in the literature, but observing how *JTF* works in a more urbanised environment would certainly be of great value if the game is to be thoroughly tested for its potential as a vehicle for environmental education.

7 CONCLUSIONS

The findings clearly demonstrate that the *JTF* game supports teaching and learning in both the indoor (mainly computer activity based) and outdoor learning environment. The game also shows that individual and group tasks can be designed that bring team members together to engage in co-operative learning.

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