

## Play2Learn: A Case of Game Based Learning Approach in ICT Education

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### Abstract

*This study has utilised a game-based learning (GBL) approach using a case Play2Learn to engage students in learning and enhance their programming skill sets. The paper gives a detailed narrative of how educational games were first mapped with the curriculum of a programming course, and then two separate student cohorts pursuing an introductory ICT course were invited to participate in the GBL experiment. One student cohort had not yet started the programming module, while the second student cohort had recently completed the introductory module on programming. Findings reveal that educational games add to the fun element in learning, with students rating the game as an effective way to learn programming. The study contributes to the use of gaming elements for ongoing development of innovative pedagogies in teaching and learning.*

### Keywords

Game based learning, ICT education, Educational games, Teaching and learning pedagogies

### INTRODUCTION

The application of technology-enabled solutions in everyday activities has had a pervasive effect on ICT education. There is an increasing demand in the analytical, technical and programming abilities of emerging IT graduates by the computing industry. To build up the problem solving capabilities in students, ICT courses are designed with many practical elements. However, after entering into ICT related courses (e.g., programming, networks, databases), many students find it difficult to relate the taught concepts to the real world, so find the course to be dry and boring, which lowers their motivation and interest in learning (Prensky 2003; Sarkar 2006). If students are not interested or motivated, it would be difficult to keep them engaged in classroom activities. To enhance student learning in achieving required IT based skill sets, innovative pedagogical approaches are applied to teaching and learning (T&L) practices. Behavioural scientists suggest utilising fun based interventions to engage active learning as an effective pedagogical approach. One such approach to adding fun elements to classrooms are use of game-based learning (GBL) or serious games, whereby people of all ages and genders can play games for many hours without realising that they are potentially in a T&L environment (Soflano 2011). Gaming activities are good source of fun, providing instant gratification to players when tasks are completed successfully and gaming stages accomplished. In fact, gaming elements or other types of gamification strategies are being applied to workplaces, with one German automotive company Volkswagen labelling this as “the fun theory” to empower employees (Huang and Soman, 2013).

Directed teaching is an inescapable part of classroom environment, where lectures are designed to explain theoretical concepts which are complemented with practical experiments. Teachers then evaluate students with a set of formal assignments and exams. However, T&L environments could be made more fun if critical skills are taught both through directed teaching and game-mediated interventions. This would make students more engaged and motivated, and change the student’s mindset that the journey of learning is not dry or boring, but can be fun. This study attempts to address this gap by utilising a GBL approach to T&L context using a case involved in ICT education.

The paper first gives some highlights on current literature in pedagogical approaches to ICT education, and how educational games have been used in previous studies. The case Play2Learn (a pseudonym) is introduced next, followed by an explanation of how the chosen educational game has been mapped with a subject module in the ICT curriculum. The experimental design with two different student cohorts is explained next. The paper then proceeds to discuss the experiment findings using quantitative and qualitative methods to identify any

significant/insignificant correlations with diverse datasets. Finally, the paper concludes with an overview on our findings, leading to further contributions in the ongoing quest for innovative pedagogies in T&L environments.

## **PEDAGOGICAL APPROACHES TO ICT EDUCATION**

Computing is interwoven in almost all facets of managing and running a business. Further, it is expected that technological applications will be getting more efficient and advanced over time, requiring a more skilled workforce. A study investigating critical IS/IT skills from the perspectives of seventy managers suggests web applications, online services, networking protocols, wireless communications and their applications to be the most important five skills in the future (Lee and Mirchandani 2010). Moreover, the growing use of technology in our daily lives has added to the onslaught of technology courses offered by education providers. Students are enrolling in these courses to learn new technologies in classrooms, as they comprehend how technological solutions are being applied by the current workforce. However, IT students face many challenges in grasping conceptual understanding and logical reasoning of how the topics such as hardware, programming, databases or networks are used in real world applications. "Students could not transfer knowledge gained from either lectures or theoretical exercises to practical exercises. Without having direct hardware interaction, students learning becomes abstract, which leads to their displeasure and to the main question: Why we are learning this, and how and where shall I use it?" (Stolikj et al. 2011, p. 340). To help students relate the course contents to real world examples, a blended learning approach has been suggested. This approach consists of a mix of teaching deliveries, namely (1) Classroom: traditional teaching, (2) Website: web based self-paced learning, (3) Actual lab: real experiments, and (4) Virtual lab: visualization techniques such as animation (Xie et al. 2008).

A game-based eLearning study identified ICT students had issues in discerning how taught constructs can be applied when analysing a problem when there is no single, simple or well-known solution. "They have difficulty handling the ambiguity and vagueness that can arise during database analysis. Students can also display an inability to translate classroom examples to other domains with analogous scenarios, betraying a lack of analytical problem-solving skills. For the students, these problems can lead to confusion, a lack of self-confidence and a lack of motivation to continue" (Connolly and Stanfield, 2006, p. 462). Another study on ICT has suggested use of interactive computer games which simulate some problem based scenarios to scaffold classroom teaching, since they provide more opportunities for collaboration and reflection, which in turn will lead to increased motivation (Connolly et al. 2006). Papastergiou (2009) evaluated the learning effectiveness and motivational appeal of a computer game targeted at the learning of computer memory concepts for high school students. Results showed that the gaming approach was very effective in gaining students' understanding of computer memory concepts. Study proves not only learning effectiveness, but, also provides solution to the 'feeling bored' issue. One of the participants has responded: "It's more enjoyable and active. You never get bored as in traditional teaching because you concentrate on a goal." Ebner and Holzinger (2007) used an educational game IFM (Internal Force Master) in a mechanical engineering study programme. Their findings demonstrated high levels for user empowerment and fun elements for the students who played IFM. The student experience showed their readiness to play the game a second time in the event of a failure, as students were keen to go over the game problem again to find their mistakes. However, the study did not find noticeable difference in students' results between those students whose learning involved IFM game play, and those students who had learnt in a traditional classroom environment.

Another study has described design of an educational framework through an iterative development process resulting in a game that can improve student engagement, satisfaction and skills transfer (Barnes et al. 2007). Researcher used students who had completed at least one computer science course and were moderately familiar with programming concepts. Each participant was given two games to play, that is Saving Princess Sera and The Catacombs. Participants gave pre-test prior to the game play and post-test after the game play. Both the tests contained problems where students had to determine the outcome of programming components such as 'if-then-else' statements and 'while' loops. Study found that despite poor test results students were able to understand most of the various programming quests and the feedback of the students was extremely positive. In the response of the question of whether or not the participant thought the game could be used to teach introductory programming, one participant said, "Yeah! I mean, it would be awesome if like, after a lecture, the professor just said 'Alright, get to level 43 this weekend.' I would have definitely wanted to be in that class." Computer games are thus transformed into social experiences in classroom settings, to offer a constructivist approach that are interactive in nature and generate meaning in learning (Hamalainen, 2011).

## **THE CASE**

The case described herein as Play2Learn is a non-university education provider offering ICT related subject courses at different study levels designed by New Zealand Qualification Authority (NZQA). NZQA is a government organisation responsible for managing the New Zealand Qualifications Framework (NZQF), and is

the absolute source for accurate and current information on quality assured qualifications in New Zealand. NZQA administers the secondary school assessment system, provides independent quality assurance of non-university education providers, and recognizes qualifications by setting specific achievement and unit standards for approved courses (<http://www.nzqa.govt.nz>). In March 2014, interviews were conducted with experienced IT tutors at Play2Learn to identify learning challenges faced by students pursuing ICT curriculum. Interview findings revealed tutor's perceptions of T&L issues faced by students and suggestions to mitigate those issues. Identified issues are difficulty in transferring theory knowledge to practical exercise, difficulty in relating course contents to real industry use, lack of interest in course contents, and also difficulty in understanding conceptual topics due to lack of analytical and logical skills. The tutors' suggestions likewise affirmed the use of GBL strategy to encourage participation and bring about active learning through simulations of problem based scenarios in an animated environment. Further, they suggested topics related to programming constructs as being very challenging for students. Accordingly, the subject module of "programming" from the course 'National Diploma in Computing' at level 5 was selected. Programming is broad topic and contains many more sub-topics; however the fundamental components such as sequential logic flow, if-then-else, loops, functions and recursions were selected for the GBL experiment.

Play2Learn runs many courses in parallel with different student cohorts. For this study, we selected two student cohorts who were at different stages in their level 5 study programme. Cohort 1 comprised of 20 students who had not yet started studying the programming module, while cohort 2 students had 24 students who had recently completed the programming module. Further, both cohorts had yet not been assessed through a final examination process, which was a requirement for completion of the level 5 diploma course. Next, we selected an educational game (LightBot 2.0) for investigating the effectiveness of GBL in T&L environments. An experiment utilising this game was conducted in May 2014 with both student cohorts in two separate classroom settings.

## THE EDUCATIONAL GAME

Two considerations in selecting the educational game were its relevance to curriculum topics and coverage of minimum number of topics. The researcher investigated many games to see how learning activities were aligned with the programming course module set by the NZQA body. After detailed search and gathering enough detail of ICT educational games, the game Light Bot 2.0 was selected. The game mechanics of LightBot have a one to one relationship with programming concepts but without using a typed language code (Yaroslavski 2014). The developer of Light Bot explained relevance of the game to programming by splitting the concepts into two groups: (1) programming practices and (2) control-flow. Programming Practices group is subdivided into planning, programming, testing and debugging stages to explain the order in which programmers solve the problem using instruction icons without actual coding being involved. The Control Flow group is made of sequencing instruction (conditional statements), procedures (functions), and loops (including recursion) to deal with the step-by step sequence of program execution. Figure 1 shows the two concept groups used in the Light Bot game.



Figure 1 Light Bot 2.0

The game was next mapped with the chosen study module (programming) based on the NZQA curriculum. Figure 2 illustrates this mapping. Light Bot 2.0 contains four stages: Basic, Recursion, Conditionals and Experts. The 'Basic' stage includes program design based on sequential flow of execution, debug and testing the program and functions/procedure. Next stage is 'Recursion' which adds different types of loops to 'Basic' level. 'Conditional' or the third stage adds more complexity by including conditions and the last stage 'Expert' is combination of all previous contents. Each stage has six levels with gradually increases complexity.

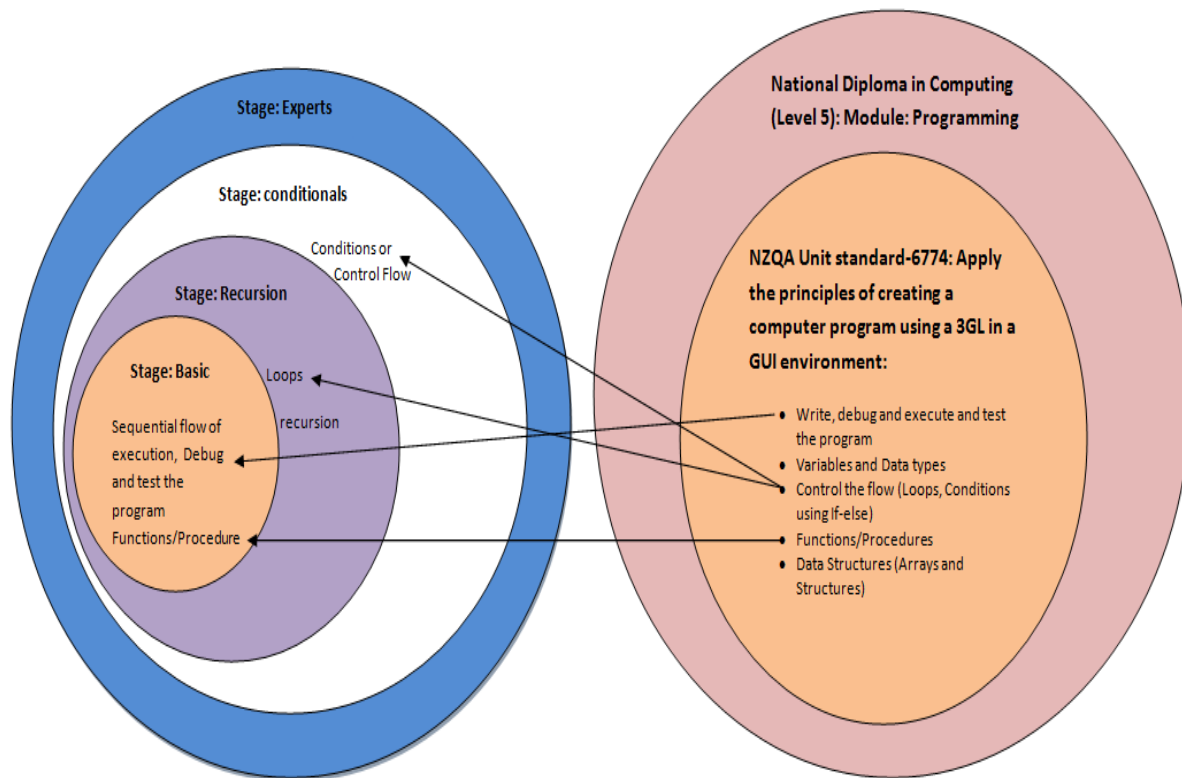


Figure 2: Mapping Programming Module to Light Bot Stages

The game utilized a fictional scenario, where players had to control a robot, whose task was to light up all the blue tiles in given walking area. This could be done through a set of commands representing basic programming concepts such as sequential execution, functions, recursion and conditionals flow.

## EXPERIMENTAL DESIGN

The Light Bot game was played by both student cohorts in two separate settings in a classroom lab environment. Cohort 1 comprise of 20 students, who had not studied the programming module, but had done some basic entry level computing courses in level 5. The second cohort comprised of 24 students. Cohort 2 was different from the first cohort by only one aspect, that is, these students had completed the 'Programming' module so they had some basic knowledge about programming.

Although the user can switch to any level of the four stages at any time during play, the students were told to play in a specific order to achieve gradual understanding of programming constructs. The order of the game and the time set for tasks was slightly different for both the student cohorts. This was because the game tasks were aligned with basic and advanced concepts of the subject modules for the two groups. The game play design for cohort 1 had steps designed to gradually introduce the complexity of the programming constructs. These students were asked to play the 'Basic' level at first, because contents in basic stage are required to understand the contents of the subsequent stages. After achieving basic level, the cohort 1 students were asked to play the first level of 'Recursion' and 'Conditionals'. The reason behind this game order was they do not miss out any programming topic defined in the game mechanics. The feedback form also had a question to assess their learning after playing the game, since these students had yet not attended the programming module. Cohort 2 students were explicitly asked to play the game in order to gain measurement of their success level. However, the 'Expert' stage was optional to play for both student cohorts and students were allowed to play this stage only after completing the game play order. Figure 3 illustrates the game play design used in this study.

After playing the game both the group of students were asked to fill an online feedback form. Both qualitative and quantitative data were collected from the online survey. Qualitative data included open ended questions to capture student voices in their own words. Quantitative data was collected using a 5 point Likert scale questionnaire. Questions were mostly aimed at understanding student perceptions of fun elements in the game, and whether they found the game difficult, or whether the concepts on loops, conditionals or recursion were clear after the game had been played. Further, only students in cohort 1 were asked a technical question pertaining to learning of programming constructs based on the contents of the game.

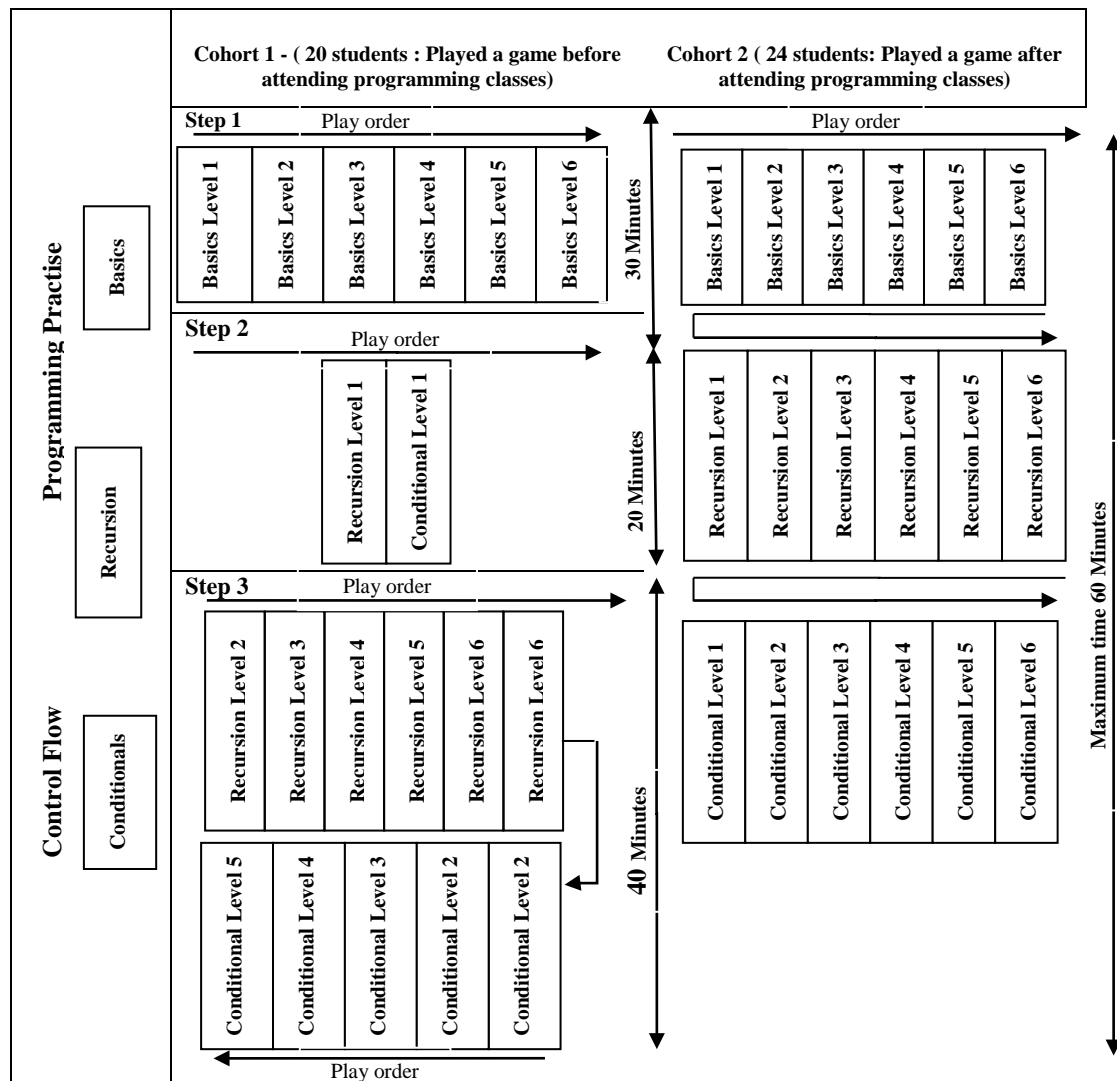


Figure 3 Game Play Design

## EXPERIMENTAL DATA

Overall, both cohorts gave positive feedback for game based learning approach and they considered it effective and helpful to learn programming concepts. This implies that GBL is effective in both the situations, before and after teaching of the related programming constructs. Raw data related to the two student cohort findings are briefly discussed next to give the reader a brief outline of the student feedback. This is then followed by quantitative data analysis to understand if any relationship exists between nominal or ordinal variables which have been collected in the survey instrument.

### Cohort 1

Of the 20 students in this cohort, 12 students had prior experience of playing educational games, though none had played the game LightBot. The game modes related to puzzle and adventure were considered livelier than other modes (i.e., role play and sports). In terms of programming constructs, sequential logic flow involving functions (or basic stage) was rated as easy, while recursion logic was rated as moderately difficult, and conditional (or advanced stage) as very difficult. For the question related to the 'fun element' in the game, half of the class rated the game as "good fun". With regard to the technical question assessing their learning through game play, 13 of the 20 students could answer the question correctly. Overall, the students perceived programming to be interesting, and ranked the game effective in their understanding of concepts to programming, such as functions, recursion and conditionals.

To the open-ended question where students were asked to describe their experience in programming, student responses varied from "boring" to "interesting". Positive feedback included comments such as "I was fearful of programing, but now it does not seem so bad", "I enjoyed recursion part – it was so brain storming" and "When I

*started, it was boring, but once I achieved levels, I wanted to go ahead, and now I understand what recursion is*". Other positive terms such as *"amazing"*, *"interesting"* and *"fun"* were sprinkled across the feedback form. However 20% of the class was not too keen on educational games and their open ended text answer had comments like *"I don't like such games"*, *"Programming is horrible"*, *"I would prefer to play this game after I have learnt programming"* and *"It was too boring"*.

## Cohort 2

The first question we asked students was in regard to the levels they had achieved in different stages. Overall, the whole class had completed higher levels in 'Basic' and 'Recursion', but had achieved lower levels in 'Conditionals'. Largely, the group agreed that the game was effective in learning programming concepts and playing the game had made their earlier taught concepts clearer. There was also much agreement on including gaming elements in the curriculum, as these elements were considered relevant to what students had learnt in their previously taught modules. However, a small percentage of the students (17%) found the game to be confusing.

In regard to the open ended question, positive feedback included comments like *"It helped me refresh my programming skills"*, *"I liked the logic"*, *"The game was pretty enjoyable"*, *"Very relevant"*, *"Makes me more confident"* and *"Good leisure time"*. Other not so positive comments included *"Did not help me"*, *"bit confusing"* and *"I don't know if I liked it or not"*. However, the general consensus on the usefulness of the game to the understanding of programming constructs was overwhelmingly positive.

## DATA ANALYSIS

This section gives a statistical analysis of the raw data collected from the survey instrument to understand if any relationship exists between nominal or ordinal variables. Nominal variables are based on fixed categorical values like nationality which can be American, Chinese, and Indian etc. The nominal variables which have only two categories often called dichotomous, like gender which can be male or female. This study included only two sets of nominal/dichotomous variables where the students were asked if they had played any educational game before our experiment or not and if they found the game confusing or not. The Likert scale ranked various aspects of GBL from largest to smallest, such as degree of fun, degree of difficulty, and degree of overall understanding. The data thus collected from Likert scale is ordinal, as it refers to ranked data, and not categorised data.

We employed Spearman's correlation coefficient method ( $Y_s$ ) and rank biserial correlation coefficient ( $Y_{rb}$ ) method to analyse any sort of relationship between the two diverse data sets for the two student cohorts. Relations are first described as positive or negative, and then can be ranked in the following order: perfect ( $Y=1$ ), strong ( $Y \geq 0.7$ ), substantial ( $Y \geq 0.5$ ), moderate ( $Y \geq 0.3$ ), weak ( $Y \geq 0.1$ ) or none ( $Y \geq 0.0$ ) (Jackson 2011; Miller 1998). Statistical analysis of the feedback data indicates magnitude of relationship for the following variables as shown in the Table 1 (for cohort 1) and Table 2 (for cohort 2).

Table 1: Cohort 1 – Data Analysis using  $Y_s$  and  $Y_{rb}$

Variable 1	Variable 2	Relationship
Degree of fun while playing the game	• Degree of agreement for the statement : "This game is helpful/effective to learn programming"	• + strong ( $Y_s = 0.761$ )
	• Degree of agreement for the statement : "I think programming would be interesting"	• + strong ( $Y_s = 0.700$ )
Degree of agreement for the statement : " This game is helpful/effective to learn programming"	• Degree of agreement for the statement : "I think programming would be interesting"	• + substantial ( $Y_s = 0.665$ )
Degree of overall understanding	• Degree of fun while playing the game	• + substantial ( $Y_s = 0.525$ )
	• Degree of agreement for the statement : "I think programming would be interesting"	• + substantial ( $Y_s = 0.597$ )

	<ul style="list-style-type: none"> <li>• Degree of overall difficulty</li> <li>• Degree of agreement for the statement : “This game is helpful/effective to learn programming”</li> </ul>	<ul style="list-style-type: none"> <li>• – moderate (<math>Y_s = -0.329</math>)</li> <li>• + moderate (<math>Y_s = 0.406</math>)</li> </ul>
Degree of overall difficulty of game	<ul style="list-style-type: none"> <li>• Degree of agreement for the statement : “This game is helpful/effective to learn programming”</li> <li>• Degree of agreement for the statement : “I think programming would be interesting”</li> <li>• Degree of fun while playing the game</li> </ul>	<ul style="list-style-type: none"> <li>• weak (<math>Y_s = -0.151</math>)</li> <li>• none (<math>Y_s = -0.069</math>)</li> <li>• none (<math>Y_s = -0.072</math>)</li> </ul>
Experience in playing an educational game	<ul style="list-style-type: none"> <li>• Degree of overall difficulty</li> <li>• Degree of overall understanding</li> <li>• Degree of fun while playing the game</li> </ul>	<ul style="list-style-type: none"> <li>• none (<math>Y_{rb} = -0.052</math>)</li> <li>• none (<math>Y_{rb} = 0.025</math>)</li> <li>• none (<math>Y_{rb} = -0.025</math>)</li> </ul>

Table 1 shows statistical figures for cohort 1 students. Spearman’s correlation coefficient method ( $Y_s$ ) is used for ordinal values in which students had ranked their perceptions of the GBL experience using Likert scale, and rank biserial correlation coefficient ( $Y_{rb}$ ) is used for nominal values in which students were asked whether they had previously played any educational game to which they could answer either yes or no.

Table 2: Cohort 2 – Data Analysis using  $Y_s$  and  $Y_{rb}$

Variable 1	Variable 2	Relationship
The degree of game relevance to programming	<ul style="list-style-type: none"> <li>• Degree of agreement for the statement : “This game is helpful/effective to learn programming”</li> <li>• Degree of agreement for the statement : “Such games should be included in course curriculum as learning activity/method”</li> </ul>	<ul style="list-style-type: none"> <li>• +substantial (<math>Y_s = 0.543</math>)</li> <li>• + substantial (<math>Y_s = 0.429</math>)</li> </ul>
Degree of agreement for the statement : “This game is helpful/effective to learn programming”	<ul style="list-style-type: none"> <li>• Average success level of all stages</li> <li>• Degree of agreement for the statement : “Such games should be included in course curriculum as learning activity/method”</li> </ul>	<ul style="list-style-type: none"> <li>• – weak (<math>Y_s = -0.202</math>)</li> <li>• none (<math>Y_s = 0.062</math>)</li> </ul>
Student found the game confusing	<ul style="list-style-type: none"> <li>• Average success level of all stages</li> <li>• Degree of agreement for the statement : “This game is helpful/effective to learn programming”</li> <li>• Degree of agreement for the statement : “Such games should be included in course curriculum as learning activity/method “</li> <li>• The degree of game relevance to the programming</li> </ul>	<ul style="list-style-type: none"> <li>• none (<math>Y_{rb} = 0.072</math>)</li> <li>• none (<math>Y_{rb} = 0.0416</math>)</li> <li>• none (<math>Y_{rb} = -0.0833</math>)</li> <li>• none (<math>Y_{rb} = 0.0</math>)</li> </ul>



Table 2 shows statistical figures for cohort 2 students. Spearman's correlation coefficient method ( $\gamma_s$ ) is used for ordinal values in which students had ranked their perceptions of the GBL experience using Likert scale, and rank biserial correlation coefficient ( $\gamma_{rb}$ ) is used for nominal values in which students were asked whether they found the game confusing or not to which they could answer either yes or no. The next section discusses the implications of these statistical data values.

## DISCUSSION

This study has used game based learning approach alongside current teaching methods to engage students and bring about active learning for one subject module in an introductory ICT course. The study identified an educational game (Light Bot 2.0) which covered the core subject areas of a level 5 programming module. We applied this game to bring fun elements in a classroom environment, where students identified programming constructs to control a robot's movements. In the game, an animated robot utilizes logical skills associated with programming constructs to light up blue tiles as the robot moves from one place to another. When the player applies correct programming logic rules, the robot can move on tiles which light up with each correct move. In this way, the game gives instant feedback to the player for each correct move, which in turn motivates the player, who tries to light more tiles while the game slowly increases in complexity.

Two student cohorts were selected in this study. The first cohort had not yet been taught the level 5 programming module, and as such had limited knowledge in programming. The second cohort had recently completed the programming module and was at a later stage of study in their level 5 curriculum. Our findings indicate that students from both cohorts enjoyed playing the game and indicated that the game had been effective in learning some of the programming constructs (e.g., functions, procedures, conditionals and recursions).

The feedback from the cohort 1 shows that after playing the game, students perceived that programming would be interesting. The game created a positive attitude towards studying programming for the students who had yet not started the programming module. The more the students found the game enjoyable, the more they considered it an effective way to learn programming ( $\gamma_s = 0.761$ ). Data showed that the students' perceptions on how interesting they consider programming to be was strongly related to the proportion of fun in the game ( $\gamma_s = 0.700$ ). After playing the game, students felt gaming elements to be effective way to learn the programming concepts ( $\gamma_s = 0.665$ ). Substantially positive moderate relationships were also found between degree of overall understanding to the fun element ( $\gamma_s = 0.525$ ), and also between degree of overall understanding to perception of "programming would be interesting" ( $\gamma_s = 0.597$ ). 65% of the students could answer the assessment question related to programming constructs correctly. However, the data showed no significant relationships between fun element and in the level of difficulty or in the level of understanding. Overall findings indicate the more students understand a topic, as explained from the game, the more they agreed that the game is effective and the topics are interesting. This suggests using a game which introduces the course topics in an easy manner so that students are motivated to learn further. Answers to the open ended question also support this, as one student said that he was fearful of programming, but after playing the game he felt more positive towards programming. However, few students from cohort 1 found the game boring, and said that they would have preferred to play the game after completing the programming module.

These findings from cohort 2 indicate that students consider educational games as a very effective way for applying programming concepts. These students had completed their programming module, and enjoyed applying their taught skills to a gaming environment. Positive substantial relationships exist between relevance of the gaming elements to programming module ( $\gamma_s = 0.543$ ) and it being included as a learning activity in the curriculum ( $\gamma_s = 0.429$ ). The students in cohort 2 had achieved higher stages during game play, although 4 out of 24 students found the game to be rather confusing. Most of the students in this cohort said they enjoyed playing the game rather than relating them to programming concepts. However, the game also helped them revise their taught concepts, which was enjoyable more so, since they were under no pressure of their scores being graded during this activity. We asked students to voluntarily share their game scores with their peers in the classroom, however only 67% of students were happy to share their scores.

Finally, we found that most of the students liked puzzle and adventure type of games, as this stimulated them to think along those constrained gaming boundaries. Educational games thus encourage players to apply their logic and reasoning to challenging situations. Students wanted to try out new thought-provoking moves in stricter game settings, which they may not have been keen in a directed teaching and learning environment. Further, the animated scenarios in the game add to the fun element to the otherwise unexciting settings of a traditional classroom environment. Overall responses show cohort 1 students to be more enthusiastic than the cohort 2 students as we get higher degree of relationships between variables for cohort 1. We can only speculate that this may be because the cohort 1 students were at an earlier phase of study in the course, while the cohort 2 students were nearing completion of their course. The cohort 2 students were rather busy in preparations for their final



assessments for all course modules including the programming module. The cohort 2 students were trying to relate the game to programming concepts, rather than simply enjoy the game play with learning as a side product.

## CONCLUSION AND FUTURE SCOPE

We have applied an innovative way to bring about active learning in classrooms through the use of educational games. Suggestions from tutors helped in identifying a subject module that was considered to be difficult by students. This provided us with an opportunity to apply gaming elements to this subject module, namely, introductory programming, within a classroom environment. Students pursuing NZQA based ICT education courses at level 5 were selected for this study. We applied the game based strategy to one group of students who had no prior knowledge of programming, and to another group who had recently completed the programming module. In this manner, we did not set boundaries to when the game based learning should be initiated. Our findings indicate that GBL is a useful learning strategy both before the subject is taught and after the subject has been taught. The GBL experiment showed us that students were overall enthusiastic and motivated as they actively engaged in applying programming principles with the gaming steps. The students agreed that gaming approaches to learning can make classroom environments more fun and be an effective way for them to better grasp some of the difficult concepts.

This study has demonstrated the effective use of GBL as a teaching and learning activity. Students felt confident about practicing the use of programming constructs in a game scenario and were eager to help others in understanding the game strategy. We believe that in applied fields of study such as ICT, the inclusion of gaming elements with traditional teaching practices will bring about more active learning. This will be beneficial for tutors too as games would enable students to grasp technology based applications quickly in a more enjoyable learning environment. Further, our study adds to ongoing teaching and learning pedagogies, and suggests a cost effective strategy to add the fun criterion to learning. This could lead to further research in designing of ICT education curriculum, where learning outcomes of different subject modules could be mapped to related gaming elements, to bring about gradual learning, as games moved from basic (easy) to advanced (complicated) levels. The study suffers from several limitations as well, for example, we have not analysed the effect of students' interest on other variables such as the success level, social interactions and self-assessments (Huang and Soman, 2013). At the time of writing this paper, the students had not appeared for the final assessments related to completion of the programming module in their level 5 diploma studies; hence data based on success levels of students was not available. Future research will analyse student results in relation to the fun element of learning through games.

Another limitation of this study is that the game (LightBot) did not depict a real world scenario, as it covered only the introductory courses. Advanced programming would involve more complicated and intensive game design, which may be perceived differently by students. At the last, we still believe that traditional classroom teaching cannot be replaced completely since teachers play both an educator and a mentoring role; however addition of GBL essence to development of pedagogical activities will enhance the teaching and learning experience.

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