Gaming to Learn: A Pilot Case Study on Students Acceptance of Playing Video Games as a Learning Method

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Abstract

This paper presents a case study on playing video games as a method to support the delivery of a game development University module, describing the teaching methodology and presenting details on a 'gaming' for learning approach to support the module's learning objectives. It presents the formulation of a theoretical framework to evaluate students acceptance of playing video games as a learning method, and the results of a pilot study using a modified Technology Acceptance Model. The results revealed that gaming as a learning activity was positively perceived by students, finding this method engaging and relevant to their learning curriculum, playful, enjoyable, useful, easy to use, with positive attitudes and behavioural intentions to use. This pilot case study serves as a practical example of implementing video games to support learning, preparing the methodology for further research to understand students acceptance, and the effect on learning outcomes and knowledge acquisition.

CCS Concepts

• ***Human-centered computing*** → ***HCI theory, concepts and models;*** • ***Applied computing*** → ***Education;***

1. Introduction

Game development education is drawing a lot of student attention and many educational institutions are offering specialised game development programmes [EGD23]. In this continuously evolving industry, which is frequently found to be pushing the boundaries of technological innovations, the need of quality education to support excellence and professionalism in the workplace is imperative. To support and enhance teaching and learning practices, educators use diverse methods to support their students needs, with video games being one of them. Playing video games is not just for entertainment, and found its way into education with great success and significant interest in the use of entertainment and serious games in recent years [CBM*12]. However, one of the key issues in demonstrating the educational efficacy of video games is the lack of examples where entertainment games have been practically used in the classroom to support learning. This is mainly due to matching issues with lesson plans and curriculum outcomes, thus, the domain of video games for education needs further empirical evidence to explore its efficacy and acceptance as a learning method [CBM*12].

2. Video Games in Education and Technology Acceptance

Using video games is one of the many digital methods on educator's toolkit to support enhanced interactive learning experiences that engage students in the learning process, usually through the form of serious games [NH23], but also using entertainment video games. It is widely accepted that there is a range of successful gamified applications demonstrating that games as learning tools can increase motivation, support the process of knowledge acquisition and improve learning outcomes (see comprehensive review by [SC18]). However, there is diversity of opinions in the use of video games. Some have generated negative publicity, for example aggression, aggressive thoughts, issues with regulating time spent gaming and others (see review in [MGL22]). Nevertheless, research also indicated that video games can have positive impact, especially for education [CBM*12]. Studies showed that entertainment video games can indeed be as effective as serious games, with the potential to be appropriately used as educational tools [MGL22]. While there is an increasing use of video games by teachers to support their teaching and learning practices in the classroom [DEG17], there is also a need for further research to strengthen the scientific evidence on the factors that make video games a favorable educational method [Wes15].

Accepting video games in education started slowly, but has been rapidly growing [TA17]. Educators are showing increasing enthusiasm for the educational affordances of video games, and are actively seeking training on their effective implementation in classrooms [NV11]. However, their willingness to implement video games in teaching practices is often unguided, and there is a need for research into practical application in teaching environments. Furthermore, it is important to understand the students perceptions on the use of video games as a learning method, since they are used to gaming for fun and entertainment outside of the classroom. One of the most prominent methods on measuring acceptance of any

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type of information technology (games inclusive) is through the use of the Technology Acceptance Model (TAM) theory. TAM was initially proposed by [Dav89], and was developed to explain and predict the subjective perceptions of accepting technology. It investigates connections between perceived usefulness and perceived ease of use of technology, and suggests that these factors are important determinants for predicting attitudes towards the use of the technology. TAM has been extensively used for examining a range of technologies over a plethora of domains with great success. It has been recognised as a valid, highly predictive, and robust model, and numerous of modifications, revisions and model extensions have been developed and used over the years [MG15]. Especially in education, the usefulness and effectiveness of TAM for understanding key factors in the adoption of technology to support education has been proven and is widely accepted [SQMAAE*19]. However, while there is growing interest in utilizing video games for educational support, research on the learning effects require further investigation [MGL22]. More specifically, little is known as to the extent to which 'gaming' can be an effective educational method. This paper seeks to contribute in this field by presenting a case study that leverages video games and gaming to support learning, and presents details of a pilot study trialing a modified TAM methodology to explore students acceptance of gaming as a learning method.

3. Gaming to Learn - A Case Study

The case study took place at the University of Central Lancashire, Cyprus (UCLan Cyprus) as part of a particular Game Development module for a period of 6 weeks. This is an introductory module aiming to encourage interest in video game development, teaching programming skills, essential mathematics for game development, game analysis, and offer insights into the commercial and industry practices. The topics are structured into four key sections, covered in an integrated fashion for a connected delivery: basic game development, game mechanics, mathematics, and commercial aspects.

3.1. Video Games as Teaching Materials

To explore the use of video games as instructional materials, a number of game projects developed by students over the years were adapted and used as interactive tools for learning. The focus was to allow students engage with the learning process in dynamic ways, as they analyze and interact with games to understand essential game development concepts. The games were at various stages of development, ranging from completed projects to those that were only halfway through development, to learn from the different phases of development. The gaming activities were implemented as additional learning tasks during the scheduled lab time, and were put into context covering the topics listed below:

Topic 1 - Core Game Mechanics: Students played a FPS game developed in collaboration by a group of students from UCLan Cyprus and the University of Cyprus for the Cyprus Game Development Challenge 2022, achieving the first place. Their task was to focus on observations and analysis of core game mechanics such as UI, raycasting, level design, character controls, points, and progression system. The objective was to enhance students' analytical skills, understanding of game mechanics, helping them to recognize the complexities of game development.

Topic 2 - Playtesting: Students and professional game developers from WARGAMING (wargaming.net) collaborated in playtesting a mobile and a VR game for feedback, reinforcing the learning covered in the topic of playtesting. Students were instructed to observe and comment on game balance, gameplay pace, challenge, AI and NPC behaviour, and usability data collection instruments were provided as part of the activity, to help them experience pre and post playtesting data collection processes. The objective was to recognise the importance of player feedback, be exposed to methods of data collection used by professionals, critically evaluate games under development, enhance their professional awareness, and connect them with the industry. The experience report of this activity [NH23] discusses the potentials of video games and immersive technologies to support learning when utilised meaningfully and structured accordingly to meet specific learning objectives.

Topic 3 - Early Stage Game Analysis: Students played unfinished versions of two TPS games where the level included basic 3D models and placeholders, textures were low quality or missing, and did not feature any advanced lighting effects. The key core mechanics were mostly implemented, the AI enemy functionality was fairly limited, and the games had several bugs. The activity's aim was to compare this experience with the fully developed game from Topic 1, noting the differences and the impact of the polished mechanics, advanced AI behaviour, and the graphical aspect.

Topic 4 - AI Behaviour: A zombie survival FPS was used to support concepts around game AI, with focus on FSM, behaviour trees and blackboard systems for NPC behaviour. The game featured a range of AI behaviour, such as rushing, hiding, patrol and other. Students were instructed to monitor changes and transitions in FSMs, behaviour trees, and blackboard stored values influencing enemy decisions through debug mode statistics while gaming. The project's source code and the game engine editor were explored to demonstrate and discuss the implemented functionality.

Topic 5 - Example of Machine Learning (ML) in Video Games: ML applications in video games were discussed with a supporting activity focused on a final year student project investigating ML from pixels. The student trained a Mortal Kombat 2 game example using a range of reinforcement learning algorithms through OpenAI's Gym Retro platform, to simulate AI vs AI fighting. Gameplay videos for each trained algorithm, and for a human vs AI video were recorded. Students were tasked to watch these videos, make notes on the fighters behaviour, discuss and individually decide whether the video they are watching was human vs AI, or AI vs AI. Examples from commercial video games were also discussed. The learning objective was to understand the impact of ML trained algorithms on gameplay, and see examples of behavior patterns that emerge when different algorithms are applied.

Topic 6 - Player Experience in Video Games: Students were shown examples of research methods used in assessing player experience in video games, such as the use of post game surveys and focus groups. Students played a 3D optical illusions game developed by a senior student for his final year project, and were administered an experience survey for the project's data collection needs. A discussion on the importance of player-focused research in games development took place, particularly in the need of researching for improving player experience and game design, to-

gether with demonstrating example game experience and usability questionnaires. The objective was to gain hands-on experience in questionnaires and heuristic evaluations, to critically analyze and understand user feedback, and appreciate the importance of research in the game development process.

4. Technology Acceptance Pilot Study

To ascertain the extend to which gaming can support effective learning, a research methodology should be developed taking into consideration several factors and variables that are directly and indirectly affecting students, teachers, and the learning process in general. In attempt to contribute to this research domain, an experimental research methodology is under development to provide valuable insights on the integration of video games in educational settings, create knowledge of the learning benefits of this approach, contributing to widespread implementation and effective use of gaming in educational contexts. Following the end of the 6-week teaching delivery, and reflecting on the experience developed during the case study, a pilot study was conducted to formulate an initial theoretical framework and the methodological foundations for examining students acceptance of gaming as a learning method.

4.1. Methods and Instrumentation

This pilot study was set up using a modified theoretical model based on existing TAM constructs from the literature. The foundations of the model are based on the Perceived Usefulness (PU), Perceived Ease of Use (PEOU) and the Behavioural Intentions to Use (BITU) constructs as suggested in [Dav89] original model. PU refers to the degree to which the user perceive that using the system will enhance their job performance and task completion. PEOU concerns the extent to which the user believes that using a particular technology will be free of effort. BITU investigates the likelihood that the user will engage with the technology in the future [Dav89]. In addition to the basic TAM constructs, the pilot study investigated the students Perceived Learning (PL) focusing on how technology impacts the learning process, and their levels of Perceived Engagement (ENG) while using the technology, which literature suggests is positively correlated with learning [HSR*16]. Furthermore, the user's perceptions towards the relevance of playing video games to their curriculum (Curriculum Relevance - CR) was examined [DASSP17]. To explore the users levels of focus and curiosity during technology interaction, and whether they find it enjoyable and interesting, the Perceived Playfulness (PP) construct [MK01] was employed. Perceived Enjoyment (PE) [VMDD03], and Attitudes Towards Use (ATT), of the technology [SQMAAE*19] were also examined. Based on this modified TAM, the hypotheses shown in Table 1 were formulated, based on assumed inter-correlation of all constructs with Perceived Learning (PL).

4.2. Data Collection Instruments

The modified TAM implemented the generic constructs of PU, PEOU, and the BITU by [Dav89]. In addition, the Perceived Learning (PL) [HSR*16], Perceived Enjoyment (PE) [VD00], Attitudes Towards Using (ATT) [SQMAAE*19] and Perceived Playfullness (PP) [MK01] of the technology have been used. The Curriculum Relevance (CR) construct [DASSP17] was also used, with two additional questions added. The items comprising the constructs of the model have been contextually adapted to playing video games to learn games development. The final TAM questionnaire consisted of 47 questions, measured in 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), and was administered at the end of the module delivery. A demographic questionnaire was also used, capturing age, gender and gaming experience.

5. Results and Discussion

16 undergraduate students (12 male, 4 female), between 20 and 25 years of age (M=21.6, SD=1.5) participated in this study. They are considered as casual gamers, usually playing video games on average 2-3 times per week, and between 1-3 hours every time they sit to play. The degree of normality of the data distribution was tested through Kolmogorov and Smirnov's test for normality, numerical and visual inspection of data, revealing that all scales apart from Curriculum Relevance (CR, p=0.36) were approximately normally distributed, and parametric tests were used. The reliability of the scales have been previously validated and reported by their original authors, but were also tested using the Cronbach's alpha coefficient, revealing high internal consistency.

The pilot analysis begun with examining the constructs related to learning and its efficacy. Participants positively rated Perceived Learning (PL) through gaming (M=3.85, SD=.82), have Engaged during the process (ENG, M=3.84, SD=.65), and expressed positive perceptions towards the relatedness and relevance of the gaming activities to their learning curriculum (CR, M=3.96, SD=.5). They have also perceived this learning method as playful (PP, M=3.83, SD=.62). The Enjoyment (PE, M=3.864, SD=.58) of playing video games to support their learning, and the Ease of Use (PEOU, M=3.859, SD=.56) of this approach were perceived very positively, as well as the Perceived Usefulness of such learning method (PU, M=3.94, SD=.63). Participants also revealed positive Attitudes (ATT, M=4.01 SD=.75) and Behavioural Intentions to Use (BITU, M=3.64, SD=.86) this learning method.

Due to the small sample involved in this pilot study, it was not appropriate at this stage to attempt specialised statistical tests usually implemented in TAM research, but these are planned for the future. However, a multiple linear regression analysis was conducted to initially examine the effect of the independent variables on Perceived Learning (PL) to serve as initial indicator of hypothesis relevance and applicability to context, identify unexpected findings and early detection of flaws. The main assumptions of validity of a multiple regression test were satisfied, but with some multicollinearity highlighting the importance of cautiously interpreting the results. The results revealed that the multiple correlation coefficient R was 9.58, indicating a good level of prediction. The R^2 coefficient of determination was .917 and the adjusted R^2 .822, demonstrating low discrepancy, therefore arguing good fit on the model. Standard error was an acceptable .348. The results of individual predictors indicated that the effect of the independent variables on Perceived Learning (PL) resulted in a significant regression equation, ($F(8, 7) = 9.669$, $p(.004) < .05$), with an R^2 of .822, suggesting that the regression model is a good fit of the data, and statistically significantly predicting Perceived Learning (PL). The results reveal that

Curriculum Relevance (β = .993, p <0.01), Perceived Playfulness (β = 1.669, p <0.05), Attitudes Towards Using (β = .655, p <0.05), and Behavioural Intentions to Use (β = .627, p <0.05) are statistically significant (at p <0.05 and p <0.10 levels), therefore supporting the H2, H3, H7, and H8 hypotheses (See Table 1). On the contrary, Perceived Engagement which is a factor well known to be closely related to learning, was marginally not significant (β = .542, p=.083), rejecting H1, one of the primary hypotheses of this pilot study. Perceived Ease of Use (β = -.720, p =.101), and Perceived Usefulness (β = .385, p =.295), were also not statistically significant, therefore H5 and H6 were not supported. Interestingly, Perceived Enjoyment was statistically significantly correlating with Perceived Learning but negatively (β = -2.737, p <0.05), rejecting H4. A negative coefficient typically suggests that as the independent variable increases, the dependent variable tends to decrease, therefore further research is required, as it could be hypothesised that when students enjoy playing games beyond their educational purpose, these can negatively impact their Perceived Learning.

Table 1: *Results of Initial Hypotheses Testing*

Hypothesis	Confirmed?
H1-Perceived Engagement (PE) → PL	No
H2-Curriculum Relevance (CR) → PL	Yes
H3-Perceived Playfulness (PP) → PL	Yes
H4-Perceived Enjoyment (PE) → PL	No
H5-Perceived Ease of Use (PEOU) → PL	No
H6-Perceived Usefulness (PU) → PL	No
H7-Behavioural Intention to Use (BITU) → PL	Yes
H8-Attitudes Towards Using (ATU) → PL	Yes

6. Conclusions

The results of this pilot research suggest that the potentials of learning through playing video games as an educational support tool are promising. This case study serves as a practical example of implementing video games to support learning, offering an engaging method delivering complex concepts such as game development. Pilot data collection and analysis indicated that students experienced playfulness, and enjoyed playing games, perceiving this method as useful and easy to use, with very positive attitudes and behavioural intentions to use. The pilot study helped formulating the theoretical framework for a future investigation based on this modified TAM methodology. The initial hypotheses and statistical analyses helped to refine and identify issues with the experimental process. Future work will focus on evaluating the proposed theoretical model through larger sample, to further investigate the complex relationships among the identified constructs. Using video games for educational purposes align with modern pedagogical approaches with emphasis on experiential learning, engagement, and application of theory into practice. However, additional research is essential to understand the impact of gaming on different types of learners, and exploring the effects on learning outcomes and knowledge acquisition. Further research will help validating the acceptance of gaming and the learning effectiveness of this approach, contributing to the development of innovative educational strategies that resonate with the young generation of learners.

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