Game-Play: Effects of Online Gamified and Game-Based Learning on Dispositions, Abilities and Behaviours of Primary Learners

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Institute of Education, Dublin City University, Glasnevin, Dublin, Republic of Ireland
jawaher.alghamdi2@mail.dcu.ie; charlotte.holland@dcu.ie

Abstract. This meta-level review of the literature set-out to examine the impacts of game-based/ gamified learning on dispositions, cognitive abilities and behaviours of learners aged 6-12, and to identify the factors that contributed to these impacts. A total of seventeen relevant studies were identified that had been implemented across a range of disciplinary areas in the period under review (2005-2015). The results indicate that online gamified/ games-based learning has been shown to increase the level of academic performance of learners, and improve cognitive competencies in problem-solving, multiplicative reasoning ability, self-efficacy and critical thinking. Learners' intrinsic motivation has been shown to have been enhanced through motivational factors (confidence, satisfaction and enjoyment) promoted within the online game design, and this had a direct effect on increasing engagement and improving academic achievement.

Keywords: Gamification, Gamified Learning, Primary Education.

1. Introduction

The availability of new platforms and online technologies for the delivery of games has become an important factor in 21st century learning. According to Prensky [1], our education system needs to respond to the needs of our "digital natives" who, having grown up with the proliferation and permeation of technologies in their everyday lives, are said to be more technologically savvy and to process information (or learn) differently to previous generations. However, others such as Helsper and Eynon [2] contest the evidence base for such generalization that forms the basis of the concept of digital natives and instead have provided evidence that digital natives are perhaps better identified across a broader range of factors which move beyond the narrow generational concept, including the degree of immersion in the technology (i.e. breadth of online activities) and experience in using technology, as well as socio-demographic factors (gender dimensions and educational levels). Helsper and Eynon [2] further call for more evidenced based research exploring how younger and older generations learn through and engage with technology, so that our education system can respond appropriately to needs of our learners. In order to keep up with ever-changing information and communication technologies and to prosper within dynamic social, cultural and economic environments of the 21st century, learners need to develop and/ or enhance skills such as critical thinking, teamwork, digital literacy,

problem solving, collaboration and cooperation. According to Prensky [3] computer games provide a new way to motivate learners. Gaming is particularly important in supporting learners to interact, communicate and collaborate with each other, and thus can help facilitate types of learning required for 21st century living.

This review of the literature set-out to identify factors that impact on dispositions, behaviours and/ or cognitive abilities of primary level learners' (6-12 years old), in game-based/ gamified learning environments. For the purpose of this study, game-based learning refers to the use of stand-alone online games within learning contexts and the gamification of learning refers to features of gaming, such as competition and rewards systems, being used within online learning contexts.

2.   Methodology

The electronic databases searched in this review were Science direct, IEEE (Institute of Electrical and Electronics Engineers) and Springer. The search terms included: "online game–based learning" "online digital game-based learning", "gamified learning" and "gamification", along with more specific terms such as "primary education" and "younger learner or children". The following search results were obtained: Science Direct (590 papers), IEEE (107 papers) and Springer (395 papers). Studies were selected with the following inclusion criteria; 1) have been published from 2005 to 2015, 2) have focused on primary education aged 6-12 3) have been written in English language. It also should be noted that only those games employing an Internet or Wifi connection were considered 'online', and, consequently, papers presenting research on topics, such as digital based-learning without use of internet connection, were not included in this review.

Given the permeation of broadband/ wifi and mobile technologies, this study took a particular focus on games being used for learning purposes that were accessible online through commonly used mobile devices with wifi connection (laptop and/ or tablet technologies) and desktop computers with an Internet connection within classrooms or at home. Console games were thus excluded, as they are not *commonly* integrated within classrooms, as console games are often beyond budgetary constraints of many school systems – we do recognize that there are some notable exceptions to this such as Learning and Teaching Scotland's exploration and promotion of consoles in Scottish classrooms from 2006 onwards. Furthermore, there was emerging anecdotal evidence at the time of this review of games traditionally accessed via consoles being translated for use via PCs and/ or mobile devices (the launch of Microsoft Educational Version of Minecraft in 2016 which is accessible by PC and Mobile phone is evidence of one such recent translation) Furthermore, this study was particularly interested in online games being used by the 6 to 12 year old age group. As such, the research terms used narrowed the search field to include games employing an Internet or Wifi connection for 6-12 year olds, while excluding console games. In total over 1000 papers were isolated using the initial search terms, and following a manual reading and review of each of these, only 17 studies were found to have met the criteria as outlined above for this meta-analysis, as explained below

To enable the implementation of the selection criteria, and given the diversity of online games, two steps were taken in the selection process. First, during abstract screening, records reporting the same study were clustered together. Second, during full-text vetting, the references were reviewed, which resulted in the delivery of several papers relevant for the review but not covered in the databases. The literature review uncovered seventeen papers reporting on studies exploring the impact of online game-play. The questions that guided the review of each of the selected papers were as follows:

- What does this study reveal about dispositions, cognitive abilities and/ or behaviours of learners within online game-based/ gamified learning environments?
- What factors contribute to changes in learners' dispositions, cognitive abilities and/ or behaviours within online game-based/ gamified learning environments?

For the purpose of the review, Dispositions were understood as learners' attitudes or feelings towards engagement within the disciplinary area; Abilities were understood as development of learners' cognitive abilities within the disciplinary area; and, Behaviours were understood as the nature, types and degree of engagement in the disciplinary area within and beyond the classroom.

The findings from the selected papers were initially coded according to whether an increase, decrease or no change was recorded in the dispositions, abilities and/ or behaviours of learners. The age-group, disciplinary area and size of study were also recorded. In addition, factors that contributed to changes in dispositions, abilities and/ or behaviours of learners were noted. The outcomes from the coding process were then cross-tabulated to ascertain common outcomes and corresponding themes, and these were then presented within the frame of discussion under the headings of 'Dispositions', 'Abilities' and 'Behaviours' in game-based/ gamified learning contexts.

3.   Nature of studies under review

Seventeen studies were identified that focused on online game-based learning/ gamification across a range of disciplinary areas. Overall, the studies adopted research approaches that utilised solely quantitative or mixed methods, with solely qualitative approaches being less common. Furthermore, studies measuring cognitive abilities (academic achievement) tended to use pre-testing and post-testing of abilities, whereas the studies of behaviours and dispositions tended to use direct observation as their research tool of choice.

A variety of different online game-based learning contexts have been used; a cooperative educational online computer game [4], a collaborative educational online computer game [5, 6, 7], mini games [8, 9] and 3D online environments [10, 11], constructing games [20].

Mathematics and Science were the most common disciplinary areas for the studies under review. Five studies implemented online games in Mathematics course [4, 9, 14, 17] and another seven studies were in the disciplinary area of Science [6, 7, 8, 11, 12, 13, 15]. The remainder focused on other disciplinary areas, such as Geography [5,

10], English [5] and Literacy skills-Reading [18].

Most of the studies sought to explore the effect of engagement in online games on learners' dispositions. A number of studies explored the impact of engagement in online games on the learners' cognitive abilities such as problem solving, multiplicative reasoning ability and academic achievement. While a few studies examined the effect of engagement in online games on learners' behaviour, this review has found that only three studies have implemented gamification elements. Two of these studies integrate gamification elements within 3D virtual worlds [11, 20]. The study by Su et al. implemented gamification elements in a mobile learning environment [6].

4.   Impact of online game-based learning /gamification on dispositions

Eleven studies focused on the effect of online games on learners' dispositions and attitudes [4, 8, 10, 11, 12, 13, 1], 18, 20]. A variety of types of online gaming products, including 3D immersed games [10, 11] and mini games [8, 9] which support social interaction (cooperation, collaboration) and competition have been shown to positively enhanced primary learners' dispositions toward learning across a range of different disciplinary areas [8, 9, 10, 11].

Game-based learning has been shown to promote an increase in positive attitudes towards disciplinary areas [4, 5, 12, 13, 14, 19] to make the learning experience more enjoyable [14] and to promote engagement beyond the classroom [19]. This can lead to learners exhibiting independent behaviours (becoming more self-directed, autonomous) and a positive shift in their interest towards the process of learning, as opposed to focusing on academic grades [10].

Game-based learning supports this through the inclusion of motivational gaming features such as fantasy and relevance [12], collaboration and team-based type activities [5], and appropriately designed aesthetic interfaces with attractive illustrations for example [5]. Immersive gaming environments that support 3D virtual engagement among multiple players were further shown by Tüzün et al. [10] to increase motivation through use of exploration, interaction, collaboration and through activation of player presence. The act of constructing games was also shown to increase positive attitudes and motivational levels [20], particularly if it involved experimentation and sharing of ideas – learners liked 'messing around with scripts' [20]. Ronimus et al. [18] found that the presence of reward systems had an initial significant positive effect on concentration levels. Su and Chengt [6] found that leaderboards, badges and missions increase learner engagement. Kuo [12] found that game and non–game learning environments should be more fun to motivate learners and keep them on task.

There were some cautionary notes about use of game-based learning in some of these studies. In a study by Ronimus et al. [18] when the novelty of using reward system within games wore off, the learners' engagement decreased. Furthermore, Ke & Grabowski [4] found that cooperative game-playing encouraged more positive dispositions than competitive game-playing towards the disciplinary area of maths. Also gaming environments without a sufficient degree of learning challenge – such as

those involving just the gathering of information - can be perceived as boring as shown in a study by Tüzün et al. [10], thus decrease levels of motivation, engagement or interest in disciplinary area.

5 Impact of online game-based learning/gamification on cognitive abilities

Nine of the studies specifically explored the impact of online games on learners' academic achievement [4, 5, 6, 7, 8, 9, 10, 12, 13, 15] Some of these and other studies further examined the effect of online game-based/gamified learning on specific abilities such as problem-solving skills, multiplicative reasoning ability, self-efficacy [4, 5, 6, 7, 8, 10, 11, 12, 13, 15]. In terms of academic achievement, the results of these studies found game-based/ gamified learning in general led to improvement in learners' academic achievement. This improvement comes from learners' enjoyment, involvement and satisfaction within the online gaming process [4, 5, 6, 8, 9, 13].

Overall these studies of online game-based learning/gamified learning have reported improvements in learners' cognitive abilities such as: problem-solving skills [11, 15, 17, 9], factual knowledge [5], self-efficacy and confidence [6, 7, 15] and in learners' academic performance [4, 5, 6, 7, 8, 10, 12, 15].

Online game-based learning/gamified learning has been shown to enable improvements in learning performance, knowledge and/ or skills-sets through the use of the constructivist platforms and communication interfaces that promote collaboration, increase players enjoyment and/ or value the ownership and personal expression [17]. In terms of academic achievement, Hwang et al. [8] found that competition and challenge of the online game resulted in an increase in learners' interest, with fuller involvement, concentration and enjoyment, and improved performance. In a study by Filsecker et al. [11] players interacting with each other through the 3D virtual space were shown to have a greater understanding of key concepts and increased interest in solving problems. Sung & Hwang [13] found that collaborative computer games enhances learners' confidence and self-efficacy.

Participants in a study of a mathematics educational game by Costu, Aydın & Filiz [14] highlighted the need for enjoyment in educational games, but also cautioned about the need to keep a balance between entertainment and knowledge dimensions of game-based learning environments, recommending that the game be well-connected to the lesson learning outcomes. They further recommended that a competition-type use of the game would likely increase the level of engagement in the game.

A study exploring the potential of mobile gamified learning by Su & Cheng [6] highlighted the positive correlation between intrinsic motivation and learning achievement. In this case, the use of gamification features such as leaderboard, badges and mission resulted in an increase in learners' interest and satisfaction, and thus, positively impacted on their intrinsic motivation, which in turn is reflected in an increase in their academic performance.

A study by Vos et al. [20] concluded that game-makers demonstrated more cognitive competence (in deep learning strategies) than those who just played existing games. This indicates that the process of game creation is of more value from a cognitive perspective than that of game-playing.

A study into 3-D immersive learning environments by Tüzün et al. [10] showed significant learning gains among participants but highlighted the importance of the promotion of cooperative game play (with peer support) as opposed to competitive game-play (with no peer support). They concluded that co-operative game-play led to positive increases in both the participants' dispositions and academic performance, whereas competitive game-play only resulted in improved academic performance. A study by Ronimus et al. [18] on web-based game learning reported improvement in academic performance but cautioned that activities which are perceived by learners to have too high a degree of learning challenge can result in decreased interest in that activity.

A study of web-based geography game by Dourda et al. [5] showed considerable improvement in content knowledge and highlighted the need for cooperation with peers in achieving the learning outcomes. Dourda et al. [5] also found that teamwork, communication and collaboration inherent in game-playing enhance learners' satisfaction and enjoyment. A number of cognitive strategies were displayed, including abilities in skimming, scanning and translating web texts. Furthermore, it was noted that face-to-face compensation strategies (including gestures and facial expressions) were used in to overcome limitations in understanding the English language (their second-language) within the web-based content. A study by Garcia & Pacheco [17] further found that online game-based learning can improve understanding of key concepts and improve cognitive skills, through the use of collaborative elements in problem solving and by helping learners to build their own knowledge, and by providing direct contact with real problems.

In contrast, according to Kuo [12] learners' academic achievement can be improved by game and non-game learning environments. He found no significant difference for learning outcomes between online game-based learning and non–game based learning. The author concludes that design for both learning environment should be more fun to motivate learners.

6 Impact of online game-based learning/gamification on behaviours

Eight of the studies explore the impact of online games on learners' behaviour [5, 9, 10, 11, 12, 17, 18, 19]. The results generally are positive with respect to learner behaviours. For instance, Kuo [12] found that learners visit online game environment after school time where no homework was required. Furthermore, the learners enjoy teamwork in the collaborative learning environment [5, 10]. Sandberg et al. [19] reported that learners spend more time within the online learning environment. Ronimus [18] found the level of learning challenge increased playing time. Online games provided direct contact with real problems and provide better opportunities for promoting the participation by children [17]. On the other hand, Filsecker et al. [11] noted that gamification elements such as external rewards did not show any effect on learners' levels of engagement and playing time [18].

From a review of these studies, it is clear that online game-based learning/ gamified learning can have positive impacts on learners' behavior, specifically in terms of increasing the level of engagement in learning activities within and beyond

the classroom [5, 9, 10, 12, 17, 18, 19], but can also include features that negatively impact on engagement [11, 17].

The level of engagement of participants can be increased in online gaming through raising intrinsic motivation [8, 12], through inclusion of activities incorporating competition [14], through the inclusion of group work [5], and through self-directed activities that promote ownership and agency [5].

Participants in a study by Tüzün et al. [10] were so motivated by engagement in game-based learning that they had to be ejected on occasion from the computer room, and furthermore expressed the desire to play the game outside school time. In a study by Sandberg et al. [19], participants were motivated to engage in game-based learning in their own time by the use of smart-phone technologies platform. A study by Garcia & Pacheco [17] showed that the interactive platform provided direct contact with real problems and provides better opportunities for promoting participation of learners.

In a study by Hwang et al. [8], participants were found to be highly engaged in game-related activities that promoted intrinsic motivation. The level of intrinsic motivation was examined through flow-experiences. In the flow experience, participants fully engage with and are fully focused on the activity, and thus become intrinsically motivated to remain engaged in the activity (Csikszentmihalyi, 1975, as cited by Hwang et al.,) [8]. The degree of learning challenge, control and enjoyment are core factors that can impact on the flow-experience, and thus, the levels of intrinsic motivation. In the study by Hwang et al. [8], the flow experience in the experimental group was shown to have significantly improved through the inclusion of 'instant interactions', 'explicit objectives' and 'dynamic challenges' within the game. A study by Ronimus et al. [18] showed high level of [learning] challenge increases playing time and concentration.

A study by Costu, Aydın & Filiz [14] recommended the inclusion of competition features to increase levels of engagement by participants within game-based learning contexts.

In other studies, it was noted that the process of gaming promotes team-work and collaboration [5], and can result in increased desire to engage in learning at home [10].

Some studies have highlighted how particular features of online gaming/ gamified learning environments can reduce levels of engagement. A study by Garcia & Pacheco [17] found that engagement can be negatively impacted by differing levels of abilities among group of participants (particularly when gaming occurs in the absence of supervision/ outside of class-time). Moreover, Garcia & Pacheco [17] found that differing levels of computer skills resulted in participants preferring to collaborate face-to-face rather than within virtual contexts. Furthermore, a study by Ronimus et al. [18] found that while the presence of a reward can initially increase engagement, the effects of rewards as a motivating factor for engagement decreases over-time. Furthermore, this study found that shortcomings in the design of control, goal setting and feedback features in an online game may have contributed to lower participation levels within the online game. Finally, a study by Filsecker & Hickey [11] found no link between external rewards and disciplinary engagement.

7 Conclusion

This state-of-the-art review has examined the impacts of online game-based learning /gamified learning on learners' dispositions, cognitive abilities and behaviours, as well as the factors that have been found to contribute to changes in learners' dispositions, cognitive abilities and/ or behaviours. The results demonstrate that online game-based learning/ gamified learning has mainly positive effects on learners' dispositions, cognitive abilities and behaviours.

In the current review, the factors contributing to the successful implementation of game-based learning/ gamified learning in enhancing young learners' dispositions include: motivational gaming features, social interaction (collaboration), immersive gaming environments, enjoyment elements, and some gamification elements (such as: feedback, leaderboards, and badges). Furthermore, the application of constructivist principles in game-design, inclusion of opportunities for social interaction (collaborative, cooperative) and integration of competitive features within game design have been shown to have positive impacts on learners' cognitive abilities and academic performance.

However, studies have also highlighted factors reducing levels of learners' engagement and motivation, and thus impact negatively on learners' dispositions, within games-based/ gamified learning contexts. These include games with low levels of challenge and, conversely, games that promote competition between players, which have been shown to result in decreased levels of motivation, engagement or interest in disciplinary area; thus, impacting learners' dispositions. Interestingly, studies of games-based learning with too high a degree of challenge have also been shown to decrease learner interest and to negatively impact on their cognitive abilities and academic performance. Finally, game-designers need to be mindful that gamified reward system (whether attempting to motivate intrinsically or extrinsically) can positively, or negatively, impact on motivation levels of learners.

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