

# To what extent do game design factors impact children's engagement on digital education games?

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## ABSTRACT

This study explores the extent to which game design features impact children's engagement with digital education games (DEGs). Research has highlighted that the topic of digital game-based learning (DGBL) is becoming increasingly complex, with benefits such as the acquisition of 21<sup>st</sup> century skills as central to its implementation. However, in this field of literature a void is presented around experiences of gaming platforms and how engagement can be heightened. To investigate this, an empirical, qualitative study was undertaken, utilising mixed methods and a sample of 6 children aged 10-12. The findings of this study generally supported existing literature. However, there were two emerging themes; - the mode of questioning posed by the game, and the extent to which the DEG supported customisation and character building (characterisation) through the use of the in-game avatar and reward mechanisms. - My research aims to assess the effect that both themes had on overall student engagement with the game through consideration of the synergy between the disciplines of teaching and game-design. These arguments stressed recommendations that if tweaks were made to the way a child is both questioned and rewarded, their engagement would be prolonged, possibly heightening the long-term benefits of DEGs.

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## Introduction

Currently, policy makers are adapting the education system in the hope that it is successful in developing technologically skilled children who can thrive in an increasingly digital society. The drive to do so has been acknowledged widely as digital game-based learning (DGBL), and has been associated with: gains in student achievement (Bebell et al, 2010), the acquisition of language skills, increased motivations towards learning (Arifah, 2014) and the development of 21<sup>st</sup> century skills (Johnson & Mayer, 2010), including and criticality (Qian & Clark, 2016). While this reform is being driven with the benefits discussed above as central areas of focus, it seems that policy makers are working with targets in mind, rather than considering the importance of children's agency regarding their educational experience. This phenomenon is clearly visible in the topic of DGBL as previous research has confirmed that children are rarely consulted in the process of game design which

could affect their engagement on such platforms. This points to a clear need to pay heed to the current absent voices of children in this area of their lives, which would inevitably promote their rights according to the UNCRC. In order to capture these voices, should they exist, the research will aim to provide clarity to the following research questions:

1. What do children identify as game design features that are central to their experiences on DEGs?
2. How do the identified features of game design impact children's engagement on DEGs?

## Literature review

The integration of gaming into learning isn't a new phenomenon (Egenfeldt-Nielson et al, 2008), however, in recent years it is becoming more prevalent in formal education sectors. Digital game-based learning is often

considered to be the balance between providing entertaining/dynamic environments, as well as learning opportunities (Plass et al, 2010; Nussbaum & Beserra, 2014). Some, such as Piaget & Vygotsky (2013: 1980), argue that DGBL has the theoretical characteristics of play theory. The argument is that if children are to engage in constructive, symbolic or rule-based play (Johnson, Christie & Wardle, 2005), they can develop problem solving abilities, a common outcome from DGBL (Leong & Bodrova, 2015). Seemingly, it appears that if used correctly, DEG platforms have the ability to harbour lifelong benefits for a child's development. Much has been said to support this.

To begin, a number of meta-analyses have found there to be significantly higher learning outcomes to arise from the use of DGBL, than through the use of traditional learning methods (Underwood et al, 2008). These findings were reinforced in a later study, wherein 81% of students were found to have had better educational outcomes if taught through DGBL, than children who were not (Kavimbasioglu, 2016). While this points to DGBL positively encouraging academic achievement, this relationship remains inconclusive due to a lack of new research in this field (Girard et al, 2012). In a similar vein, research has suggested DGBL results in the acquisition of 21<sup>st</sup> century skills (Dodlinger, 2007). Many have advocated that technology is a good medium to gain such skills (Vogel et al, 2006), as not only do such platforms encourage independent study, but they also engage children in newer modes of learning that require certain skills to progress on the platforms (Ke, 2007). While the above points support the notion that DGBL is positive in a child's learning experience, there are possible adverse effects. These include, but are not limited to, causing aggressive behaviour & hostility (Batthyány, et al., 2009), decreased academic achievement (Jeong & Kim, 2010) and reduced cognitive gains (Peng & Liu, 2010). Clearly, the field of DGBL is heavily contradictory, yet what remains clear is the argument highlighting the importance game design features have on DEGs.

To begin, there is research to support the notion that different game types can elicit different degrees of engagement (Squire, 2011). For example, children are likely to experience lower learning gains if engaging in competitive gameplay, compared to playing for individual pleasure, as playing with others often disrupts the child from the task at hand and their knowledge acquisition (Zaphiris et al, 2007). Additionally, it seems that rewards and sanctions are influential with respect of engagement. As Kinzer et al (2012) argue, all games involve incentivisation systems that may encourage gamers to continue efforts or modify their behaviours in order to avoid punishment. This links to theories of extrinsic motivation (Lepper & Malone, 1987), which is characterised by an increase in engagement if a player is rewarded for their positive gameplay. Common modes of rewards can be badges, stamps, points and vouchers,

which are deemed to be effective rewards in positively reinforcing behaviours (Deci et al, 2001). The process of positive reinforcement aids learning as it results in a positive behaviour change, whilst also improving engagement. As a result, it is clear that both rewards and sanctions can influence a child's engagement, either prompting further engagement to receive rewards, or a change in behaviour to reduce the assigning of sanctions. The last element of game design which we will consider are characters and environments. These elements are often aesthetic in nature, but are linked to a child's ability to relate to the game itself (Kongin & Hoorn, 2005). Many have considered self-identification as an important component in predicting in-game engagement (Klimmt et al, 2010), as the process of choosing or creating characters allows a child to immerse themselves considerably more than having pre-assigned characters (Sibilla & Mancini, 2018). Similarly, the environment in which the game is situated, whether rainforest, city or island, may impact engagement. There is a common belief that if the environment is more convincing to the child playing, their engagement rates are likely to increase due to the heightened sense of realism (Wood et al, 2004). This may suggest that if the game's aesthetic is characterised by fantasy, clearly fictional, then engagement rates are likely to be lower. Interestingly however, there are very few digital education games based on reality and mimicking real-life situations (De Strulle, 2009), which underpins the primary justification for my research in this field.

### **Methodology, participant selection and research stages**

Fundamentally, this research adopted a qualitative approach, which aims to study a phenomenon through verbal means, rather than statistically (Hammersley, 2013). The use of a qualitative approach has been praised for its ability to elicit meaningful insights into people's lives, inducing deep feelings and emotion (Anderson, 2010). Many have considered qualitative research to be linked to empiricism, which is data collected through observation (Grey, 2017), similarly reflected in interpretivist theory which seeks to make sense of values and experiences, through different contexts and cultures (Creswell, 2007).

Regarding the sample, a process of purposive and snowballing sampling methods was adopted (Frankel & Devers, 2000b). This sample involved 6 children, 3 males and 3 females, who ranged from the ages 10-12 and which was made up of my siblings and their friends. There were ethical dilemmas such as insider researcher bias, but this was mitigated by carrying out 'respondent checks' and having multiple stages of data collection, thus ensuring that the participants' own voices came across, rather than my own agenda (Tong et al, 2007). It is important to reiterate that the generalisability of this sample is negligible as there are inherent biases, whether positive or negative, which reduce the applicability to other

groups of people (Lewis & Shepard, 2006).

After adhering to the BERA guidelines and obtaining consent and assent forms, the participants met informally and chose the 3 games to be involved in the research stages - these were: Guardians: defenders of Mathematica, Crystal explorers and Earth, squad, GO!

Regarding the research stages, the first involved a non-participant observation where the children independently interacted with each of the games, with free reign over the duration of their engagement. The second stage conducted was a focus group, which involved conversation regarding the children's gameplay (Leech and Onwuegbuzie, 2008). The use of a focus group was highly useful in this context, as it allowed for children to co-construct their ideas, feelings and emotions regarding DGBL (Wilkinson, 2004). Lastly, in an attempt to promote the silent child's voice and further validate the interpretations made during the first two stages, there was a further analysis stage drawing upon participatory methods such as arts-based activities (Russel, 2018), which allowed the children to make sense of their experiences in a child-friendly way (Syprou, 2011). The use of 'participatory methods' were useful in increasing the children's involvement in decision making (Lundy, 2007), as it was child-led and included the use of arts and crafts (McWilliam et al, 2009).

After conducting the empirical study, through the means of a non-participant observation, a focus group and an 'arts-based respondent check', there were large amounts of data which presented themselves as jargon. In order to make sense of this data, models which supported a systemic understanding of this information were applied. These models were Braun & Clarks (2006)'s thematic analysis as well as Gibb's 4 stage coding model (2011), which both aim to analyse data in a stringent and thorough way.

### **Data analysis and findings**

As predicted from previous literature, my research reflected the potential benefits and implications of DGBL, and more specifically, the influence game factors play on engagement. To illustrate, the idea that DEGs can improve academic achievement (Underwood et al, 2008) was highlighted in my own research where participant Ahmad claimed that: "We can learn more things which helps our learning".

This demonstrates that the use of DGBL and DEGs can provide a complex learning environment (Kavimbasioglu,

2016) which has the ability to improve academic outcomes (Underwood et al, 2009). Similarly, the concept of 21<sup>st</sup> century skills was particularly pertinent in literature, where the likes of Boyle et al (2016), Dodlinger (2007) and Vogel et al (2006) argued that DGBL can elicit criticality and independent thinking. Interestingly, the children identified a benefit of being able to retrieve and recap subject knowledge which aided their ability to work independently, with participant Stella claiming:

'I think that Earth, Squad, GO! was good at recapping because it will help later on when we get asked again'. This clearly demonstrates that DEGs can aid a child's future learning experiences positively. Conversely, there was much literature to consider regarding the potential negative implications of DEGs, particularly around gaming addictions and disengagement from in-class learning. While the children did not seem to have many in-depth views on this, participant John claimed that, "Earth, Squad, GO! is addictive ... I found that I didn't want to stop playing until I finished".

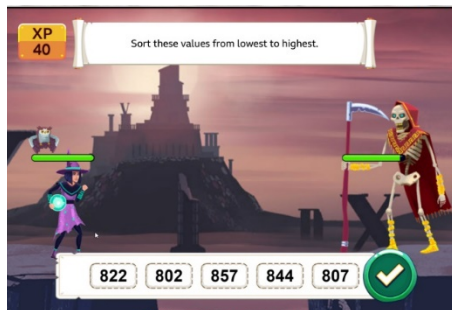
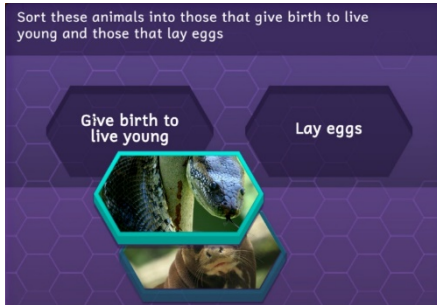
It could be argued that children whose engagement is maintained until the game is complete could be at risk of cognitive overload (Plass et al, 2003), thus reducing cognitive gains as highlighted by Peng & Liu (2010) and Jeong & Kim (2010). While these findings alone could be heavily discussed, the more pertinent findings to my research questions were the extent to which engagement with learning was impacted by the mode of questioning, and by characterisation through both avatars and rewards.

### **The mode of questioning predicting engagement**

Evident through this research was the idea that the way in which a question is presented is likely to predict engagement. Already established in the teaching discipline is the idea that teachers are advised to implement differentiation strategies (Taylor, 2017) in order to provide the most effective learning experience for children of all abilities and understandings (Brighton et al, 2005). Not only does this allow for teachers to gauge accurate assessment figures (Munro, 2012), it allows children to consolidate their subject knowledge in a way which is in line with their interests (Hertberg-Davis, 2009).

Supporting this were findings that showed visual-based questions to be more engaging as they: 'Made the topic easier to understand and were more fun and interactive'. This was starkly different to the children's experiences of questions on Guardians: Defenders of Mathematica

which were complex and comprehensive, whereby participant Hazel argued that these questions were 'Confusing and hard to understand and less exciting'. These experiences seemed to predict the children's engagement, clearly displayed through the fact that more children spent longer on Earth, Squad, GO! before becoming disengaged, compared to Crystal Explorers and Guardians: Defenders of Mathematica. The idea that visual based questions are more effective questioning techniques has been corroborated by the gaming discipline.



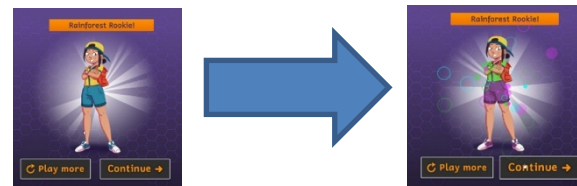
Within this pool of literature, many game developers pay regard to cognitive load theory (Borg, 1971), particularly extraneous cognitive load, whereby the way in which tasks are presented can aid or hinder a child's learning. Cognitive load theory pertains to the notion that if tasks are presented in an easily digestible way, children are more likely to engage (Sweller, 1988). Conversely, if a task is presented in a word-heavy format, like Guardians: Defenders of Mathematica, children are likely to be cognitively overloaded as the process of dismantling the information fed to them outweighs the determination to complete the task. Clearly, the mode of questioning used in gaming is essential in promoting DEG engagement, and this has been reinforced by the participants. For example, participant Stella stated that: "I think if they made the questions more like pictures and had voices attached that would be useful because I like to learn that way".

Stella's claim was echoed by Lunar, who seemed to find the visual questions not only more engaging, but also useful in answering the questions through visual aids. As can be seen in the excerpt of Lunar's observation, it is clear that the images used in the question asking participants to identifying mammals vs birds, were useful in encouraging subject knowledge retrieval, which

inevitably aided her learning. Thus, it seems that the process of differentiating questioning techniques within DEGs would not only aid a child's learning and subject knowledge, but also increase their engagement due to a more interactive and exciting gameplay experience.

### Characterisation through avatars and rewards predicting engagement.

Another poignant finding which was seemingly central to the children's engagement with the games was their ability to characterise and develop their avatars through reward systems. In particular, my findings generally indicated that DEG engagement was considerably more likely if their experience of developing their avatar was consistent and exciting throughout their gameplay. This was further corroborated by the guided conversation, where the children clearly identified that certain games were more successful in allowing the children to actively develop their avatar, in comparison to others. As can be seen from the screenshots below, taken from the children's observations, all the games apart from Crystal Explorers had rewards attached to the avatars, which would be available to the children upon meeting milestones in the game.



For example: Guardians: Defenders of Mathematica had items and equipment to unlock, whilst Earth, Squad, GO! upgraded the colour of the children's outfits. These differences in rewards systems clearly resonated with the children, who generally displayed a dislike to both Crystal Explorers and Earth, Squad, GO! for their failure to appropriately reward them. For example: Participant Grapha clearly displayed in his art-based respondent check that:

" I didn't like how crystal explorers was like proper boring, it didn't reward me and that made me feel like unsuccessful in the game"

This statement by Grapha contrasts heavily with Lunar who argued that Guardians: Defenders of Mathematica's rewards were: "motivating, encouraging and more engaging as the rewards were more worthwhile".

While these opinions were only shared by 5 out of the 6 children, these statements proved to be significant for the engagement of all participants, wherein it was made clear that the balance between rewards and accomplishment was central. This is evident also from the field of literature, which generally notes a clear need to deploy appropriate reward systems within learning environments, in order to provide an effective, holistic experience. While criticized for its 'all or nothing' approach to explaining learning experiences (Denisova, 2017), flow theory can identify the importance of meaningful rewards to children in an educational environment (Csikszentmihayli, 1975). It proposes that a child's optimal learning level is achieved when challenge is balanced with ability. In this process, the rewards should increase a child's motivations towards their learning, which not only allows them to deal with challenge but improves their ability to complete the task (Guo et al, 2009). This relates to theories of motivation, particularly extrinsic motivation theories, where children complete a task for tangible rewards, making their engagement more likely. This persistence to complete the task was clear in Hazel's observation where she persisted with her engagement in a task and then elicited: "now I get that prize thing, that's sick"

This brings my attention to another aspect of character development through gameplay, which aided the children's engagement heavily as it: "Gives more choice which is engaging"; and "Helps give a story to the game" As can be seen from the evidence provided above, the children clearly noted that their determination to complete a task hinged upon the end goal of being able to upgrade and further characterise their avatar. It is this sense of determination to develop an avatar, which relates to a child's immersion in the game and ability to integrate into the story being narrated (Harris, 2017a). The more a child can integrate successfully with this, the more they may increase their engagement as they are able to make sense of their gameplay through being imaginative etc. Following an exploration into this finding, it became clear that the children themselves identified changes which useful to game developers in the creation of future such applications. This was situated in their comments that the rewards for their characters should be "more drastic so that we can see the changes and feel like something has actually happened".

Similarly, the children suggested a store option, similar to that of Guardians: Defenders of Mathematica, where the children can choose to equip different tools to their avatar, which promotes choice and engagement. It could

be argued that making these simple changes to a game's structure would encourage children to be increasingly invested in completing game levels. If this is achieved, DEGs could harbour benefits for both children's subject knowledge, as well as engagement in that subject area.

## Conclusions and recommendations

Prior to conducting this research, a critical examination of the available literature demonstrated that there were a multitude of benefits and implications associated with DEGs. Seemingly, the extent to which DEGs can harbour these benefits and mitigate implications was down to the games' ability to mediate a complex learning environment with entertainment in order to maintain a child's engagement. If this is accomplished, it is evident that DEGs have the potential to transform children's learning.

Concerning the first research question posted through the stringent process of data collection, which involved 3 stages, it was clear that the children were able to identify which features impacted upon their engagement with DEGs. As has been discussed, these were the modes of questioning, avatars and rewards.

Regarding RQ two, it seems that the identified features of game design were fundamental to maintaining a child's engagement with the DEGs. Primarily, engaging a child with gameplay begins with their initial excitement about playing the games. I had given the children the opportunity to exercise their agency in choosing the games they would interact with, and this yielded positive results in terms of their willingness to continue with the learning process. The positive impact revealed by my research may also be attainable in a school setting, if the flexibility to offer game choices to students is available.

What has been attempted through this research is a bridging of the apparent gap between teaching and gaming disciplines and their explanations of in-game engagement/disengagement. In doing so, I have attempted to demonstrate through a multi-dimensional approach to the research, the links between the literature in the field, but also highlighting those gaps in literature which need attention. A recommendation for game developers would be to pay heed to the 'voices' of children, thus allowing them to exercise agency, thus promoting a positive learning experience. More specifically, the findings have shown that engagement is ultimately predicted by a child's immersion in the game, both whilst answering questions and gaining rewards. In

making games more child-focused, we could reform children's current negative experiences of games, that are particularly evident in my findings.

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