Chapter Two

Literature Review

2.1 Introduction

Since the first graphical interfaces were introduced, video games have kept teenagers fixed onto screens (Chow, Woodford, and Maes, 2011). This has increased even more so since mobile phones were introduced. Since so many students enjoy playing games, could this gaming aspect be combined with lessons to enhance learning? The answer to this question is gamification. Gamification is a recent trend in the field of game-based learning where educators make use of games to create lessons.

Chow, Woodford, and Maes, 2011 describe that for a number of years educators have recognized that experimental and alternative learning techniques such as gamification, if utilized correctly can be useful in helping students retain information. One very important application of gamifiaction is to aid the process of learning by improving user engagement.

Johnson et al., 2017 states that gamification can be defined most simply as "the use of game elements in non-game contexts to improve user experience and user engagement".

Wang, Shang, Briody, et al., 2011 show us that games could be a useful resource when it comes to teaching young children in a class, should it be utilized correctly. The games have to be tailored to the children's age group and must be good at grasping the audiences attention while being as educational as possible.

Batanero, Burrill, and Reading, 2011 argues that good teaching is not about making learning easy for the students, but rather it is about making it active and engaging for them, this could be done through the use of gamification. Making a difficult maths topic interesting and exciting can improve the students' learning outcome.

2.2 Comparing The Traditional Classroom Method With Gamification

Randel et al., 1992 compares the effectiveness of learning by gamification with the traditional classroom method. The author discusses the findings he obtained in the effectiveness computer games are reported to have on improving mathematics achievement scores. He goes into further detail stating that using computer games in addition to traditional classroom instruction to teach fractions to grade five students produced a significant improvement in the students' maths grades in eight different schools. Based on the results obtained by their paper it is evident that a game which properly utilizes established gamification techniques, may greatly accelerate the speed at which children learn maths topics that they would generally find difficult. A game utilizing some of the established gamification techniques was developed for this research project, the purpose of which was to aid the teaching of fractions to grade 4 students.

Hasemann, 1981 tells us that Maths, and fractions in particular is regularly a difficult subject for children to learn, particularly in light of the fact that they typically do not see any solid association among maths and its every day use.

Norton et al., 2014 created an application which was designed to give students a better understanding of partitive thinking. Partitive thinking refers to the logic behind how a fraction is just a part of a whole. Through the results obtained, Norton et al., 2014 stated that apps can effectively increase student engagement. With the use of the application, the author was

able to promote partitive thinking in the students who took part in this study at a faster and more efficient rate than those who learned only through the traditional class room method.

2.3 Determining Children's Understanding of Fractions

Peck and Jencks, 1981 interviewed hundreds of children to understand their level of knowledge on fractions. A 45 minute interview was carried out per child. The interviewer asked each child questions who then provided responses using physical materials or sketches to justify their thinking. Each child was asked to demonstrate what simple fractions such as 1/2, 1/4, or 2/5 would look like. Every student that took part in the interviews was asked to compare and to add the fractions they were presented with, and to explain the reasoning behind their decisions. Occasionally questions were also asked regarding other operations on fractions. The results of these interviews show that 55% of the students who took part were unable to demonstrate that they possessed a meaningful concept of fractions. Observations made by the authors of this paper conclude that children are trying to learn fractions only through repetitive drilling. This results in the children not having the necessary understandings of the concepts of the topic, they only manage to remember what they are able to memorize. This is because they have never been exposed to experiences that could provide them with the necessary understanding of the concepts. This shows that the traditional classroom method is flawed when it comes to teaching difficult maths topics to children. In the topic of fractions it is the first and most important object to obtain a concept of fractions (Hasemann, 1981).

2.4 Issues With Teaching Fractions

Traditionally, students are taught algorithms about fractions with little attempt to ground these concepts in a meaningful contextual basis. Children who manage to work out their

exercises on the topic do not necessarily have a deep understanding of the logic behind the solutions. Due to this, when a problem does not fit within the structure they are used to, even the most competent students can have difficulties (Davis and Maher, 1990). Children come across difficulties with fractions for several reasons. Bulgar, 2003 tells us one of these reasons may be that they are unable to see a fraction as something to be counted or as something quantifiable.

Alston et al., 1994 made links to children not being able to add up whole numbers at an earlier stage of development, though difficulties with whole numbers seem to be overcome with greater ease than fractions.

Some studies propose the idea that children may be looking at fractions differently than they look at whole numbers (Bulgar, 2003).

Other research hypothesize that the difficulty students face with the topic may come from the their inability to categorize fractions (Steffe and Cobb, 2012). Steffe and Cobb, 2012 suggested that categorization is a fundamental mental activity, which is required for children to develop methods of counting.

Teachers also feel frustrated by difficult maths topics as they seek new ways to teach them effectively. Naiser, Wright, and Capraro, 2003, go into detail discussing different strategies used for teaching fractions, and what the results of these strategies were. For this study a total of 8 teachers from 5 different separate middle schools took part. The teachers used several strategies to engage students during the fractions lessons. These strategies included real-world applications, review problems, and building on the students prior knowledge of the topic. Some teachers dominated classroom discussions keeping input from the students to a minimum, whereas other teachers were observed to be more centered around the ideas of the students. Observations were also made about how some of the teachers prompted the students to reflect about a problem and its solution. The author describes that the findings of this study indicate that lessons on fractions could be improved in multiple ways. The author mentions that student engagement is one of the biggest issues that kept coming up in

all the class rooms that took part in the study. Also another issue was how teachers should talk about the topic in a way that students can apply it to their practical lives.

2.5 The Effectiveness of Gamification in Education

Randel et al., 1992 reported that computer and mobile games are extremely effective in improving maths test results, even in children who previously had generally struggled with the subject. Randel et al., 1992 describes that seven out of eight studies on the use of computer maths games produced results which indicated that there were significant gains in maths test scores for students from first grade all the way through junior high school (ages 7 to 14). With these results it is easy for one to come to the conclusion that computer games have a lot of potential in aiding children with learning maths. Though this is only the case if the computer game is engaging and interactive. It must be able to hold the child's attention and be as educational as possible at the same time.

Yang, 2012 studied the effectiveness of digital game-based learning on students. The study lasted for a full scholastic semester (23 weeks) and was conducted on a total of 44 students of ages 15-16. Yang, 2012 compared the problem solving skills, motivation and academic achievement between an experiment group (using digital game based learning) and a control group (using traditional learning). Both of these groups received the same instructions and learning materials during the first two weekly lessons but different instructions for the last weekly lesson. For the last weekly lesson, the control group received lectures for 50% of the time and spent the rest of the time asking questions, completing hand-outs, reporting results and receiving feedback on their work. The experiment group spent 50% of the time receiving instruction from the lecturer on what strategy and design they would be trying to reach as a goal on the computer games for that lecture. The rest of the time would be spent the computer games.

Problem solving abilities were measured using standardized examinations evaluating the

ability to find causes and solutions while avoiding problems. Yang, 2012 concluded from the results obtained that the game based strategy was clearly more effective than the traditional classroom method in promoting problem solving skills in the students. Furthermore the game based learning approach resulted in higher learning motivation in the students.

2.6 Making Gamification Effective

For gamification to be effective a computer or mobile game is not necessarily required. Although these types of games would capture a child's attention more, educators can make use of physical games and less technical games to also produce effective results when teaching children difficult subjects. Chow, Woodford, and Maes, 2011, investigate using an online version of the television program called "Deal or no Deal", to improve the understanding and information retention rate of students reading for an introductory statistics course. The students can see first hand the application of statistics in this game as they are told to take the deal exchanging their briefcase with that of the banker based on the statistics whether the banker's briefcase should have the better deal or not. To study the impact of playing the game, the author compared two classes to note if there was a significant difference between the students who used the game and students who didn't. The author measured the students learning and retention by evaluating the success of the students performance at the end of the investigation. The results showed that the student who played the game did significantly better than those who did not play it.

Some games propose the use of pencil and paper. Tucker, 2014 talks about a game he created with the purpose of increasing the fluency of students in representing, comparing, and adding fractions. In his game the students need dice, coloured tiles, their recording sheets (which are used to develop and transfer their conceptual understanding of the concrete forms of fractions to the symbolic representations), and representation mats. This game proved to be effective with the students who used it, though could be more confusing to use on younger

students.

Tu, Sujo-Montes, and Yen, 2015, proposed a model to design effective gamification to support the existing lessons of educators who make use of this.

Figure 2.1 Tu, Sujo-Montes, and Yen, 2015 model on effective gamification design

This model is split up into four separate dimensions: Goal setting; Player engagement; Progressive design and Environment building.

2.6.1 Goal Setting

- Set meaningful goals: Due to the gamification process itself lacking any means of learning, it's necessary to set proper goals.
- Identify behaviours: Clearly point out what types of behaviours the game should invoke

and sustain on the users. The behaviours invoked should be used to make the users want to keep playing the game.

2.6.2 Player Engagement

- Distinguish between different player motivation types, and apply additional options to the game to cater for these different motivation types Marczewski, 2013.
- Add different mechanics to the game to make it more engaging to players.

2.6.3 Progressive Designing

- Develop PERMA (Positive Emotions Relationships Meaning Accomplishment) Seligman, 2004 instructions into an engagement loop, that cycles between motivation, action, and feedback.
- Make the game progressively more challenging. It is important to ensure the game is easy to start off but difficult to master.

2.6.4 Environment Building

- Exhibit meaningful awards: Allowing users to display their awarded badges would increase each users motivation to gain more badges. It adds a sense of competitiveness to the game.
- Engage with the users; although gamification may focus on a digital environment, it is necessary to engage learners by asking questions about what they are learning to ensure that they are fully understanding the lessons. Proper engagement of everyone involved could promote students' motivation.

2.7 Keeping Children Captivated

In order for gamification to work well, the students involved must be motivated to continue working on the exercises that are being presented to them as games. A means of accomplishing this is with the correct implementation of digital rewards. These rewards can be badges, progress bars, challenges, unlock-able content and many more types of reward systems.
Gibson et al., 2015 explains that badges, when used in combination with points and leaderboards are potentially a very powerful means of creating competition between the users. The competition this creates could be a means of motivation for the users to keep playing the game in order to get better at it. Badges can pose as additional motivation for the learners to keep improving on their performance. Gibson et al., 2015, also states that acquiring badges in game may motivate some of the users to continuously engage with the game's activities, which have been purposely designed to help them achieve intended learning outcomes. Thus the activity of acquiring badges can drive the acquisition of knowledge.
Another useful method of keeping learners captivated by the educational game, and making them want to play more of it is with the use of a story-line. Kapp, 2012 showed to what extent gamification can be used to increase engagement with the learner in the learning process. Kapp, 2012 also makes use of game design elements such as storytelling and feedback. Storytelling is used in many recreational and educational games alike, it refers to the games narrative which may be able to sustain the interest and engagement of the learners. The paper also adds that frequency and intensity of feedback are key in sustaining the learners engagement throughout the learning process, similarly to how Gibson et al., 2015 describes the use of badges and points in combination being used as rewards will aid in sustaining the engagement of the learners by creating a competitive environment between them. Kapp, 2012 also added that the balance between learning and game-play is a key success factor for a gamified educational project.

2.8 Currently Existing Solutions

There already exists multiple solutions that provide game-based learning and gamified platforms to people of all ages for learning maths. Baldeon et al., 2015 listed a number of software applications that provide such gamified platforms. Minecraft is a popular game among younger children that can be used as a platform for gamified learning. It is a sandbox game where players can break and place blocks, and at a more complex level players can even design and construct circuits. If students are already playing Minecraft at home, then teachers can use that interest and turn it into creative applications for learning. Kahoot! is a free game-based learning platform that can be used to make learning any subject fun. Kahoot! provides a game like environment where educational content is delivered by teachers asking meaningful questions. Other works are more specific and address the problem of teaching fractions.

2.9 Conclusion

Gamification in education is frequently perceived negatively due to the misconceptions around gaming. Teachers should consider the positive aspects on gaming to support learning motivation it will have on students. Given children's natural motivation to play games and considering how technology has advanced, digital games are becoming a new form of interactive media that should be explored for educational applications. Games have been proven to increase problem solving skills and learning motivation in children resulting in higher academic achievement (Yang, 2012).

With properly implemented uses of Gamification it is possible to create an engaging learning environment, where the children involved would be motivated to explore subjects that they would generally find to be intimidating with more confidence.

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