Chapter Four

Results & Discussion

4.1   Data Gathered

During the sessions that took place both quantitative and qualitative data was gathered. The quantitative data was obtained by recording the score achieved by each child and their time taken to achieve it. The results obtained were plotted into three line graphs, one line graph for each class. The qualitative data was gathered through multiple ways. The teacher who was in charge of the sessions was asked to observe the behaviours the children showed when playing the game and to take photos through out the sessions. The photos taken were only of the 2019 sessions, as the boys who played the game in 2020 did so from home since the schools were closed due to Covid-19. She was also asked some questions about the overall experience once all the sessions were concluded.

4.1.1   Quantitative Data

Quantitative data was gathered by a teacher who recorded the score and time taken for each child that played the game during the sessions. A total of 64 children took part in these sessions. The graphs below display the recorded results.
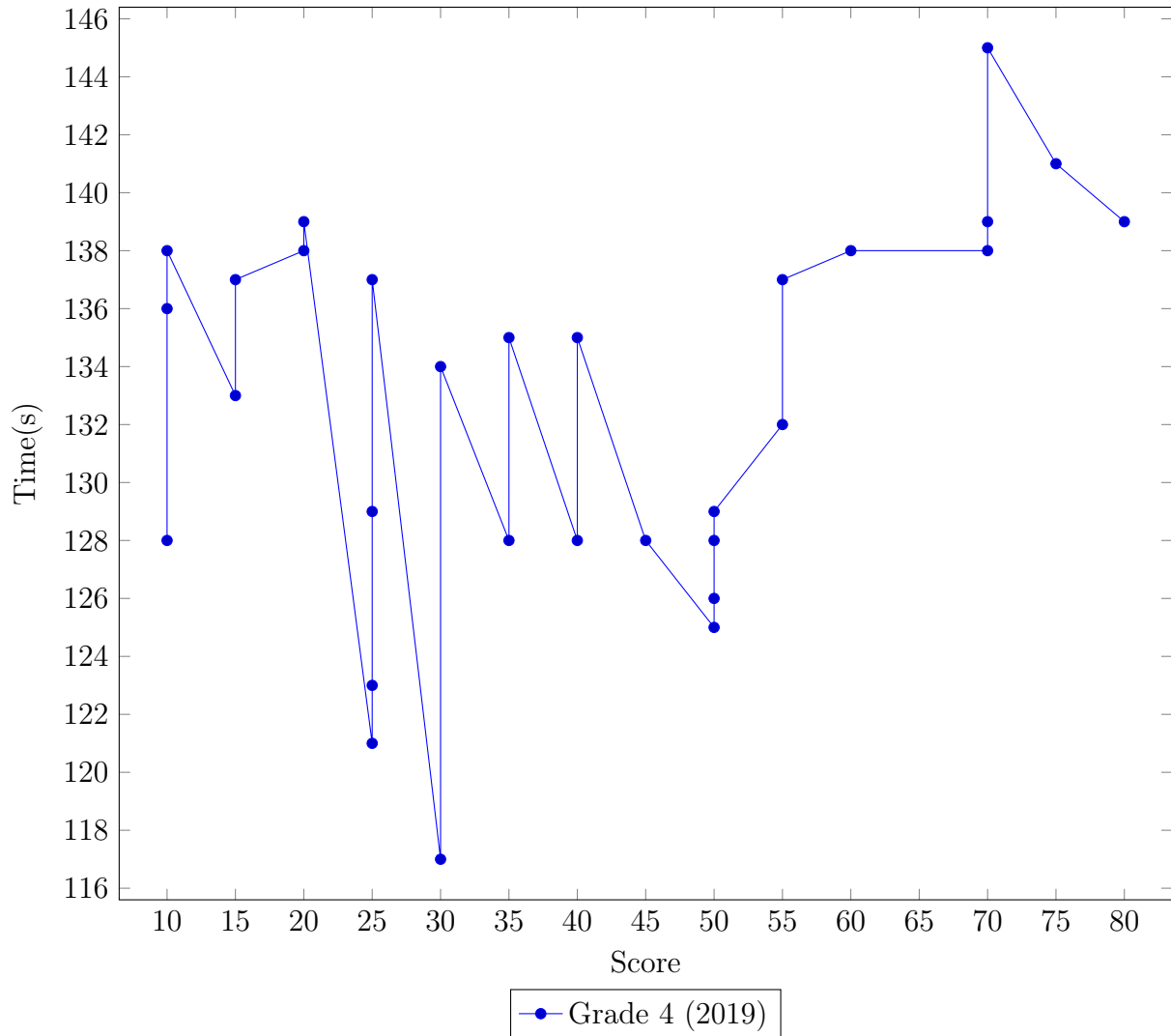
The graph above shows data acquired from both sessions of the grade 4 class in 2019. The overall feedback the children gave to the teacher about the difficulty of the game is that it started off easy but as it progressed it started becoming too difficult. The results they obtained reflect this as most of the children achieved a score below 55 points. This class had almost completed the fractions topic before playing the game. Since the children were learning the topic through repetitive drilling in the traditional classroom environment, and this usage of fractions was outside what was normal to them they struggled more with the questions. 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). This confirms that

the children do not have a meaningful concept of fractions and that they may be looking at fractions differently than they look at whole numbers (Bulgar, 2003). This could be a flaw in the traditional classroom method of teaching.

An interesting observation to note about the data on the graph is that it also seems to indicate that whether the child achieved a low or high score, the majority took their time playing the game and did not rush through the questions. This could be an indication that the gamification techniques used to create the game were effective, and the children were effectively engaged with the game (Tu, Sujo-Montes, and Yen, 2015). Another possible indication that the gamification techniques used were effective is that around half children in this class had requested to play the game again.
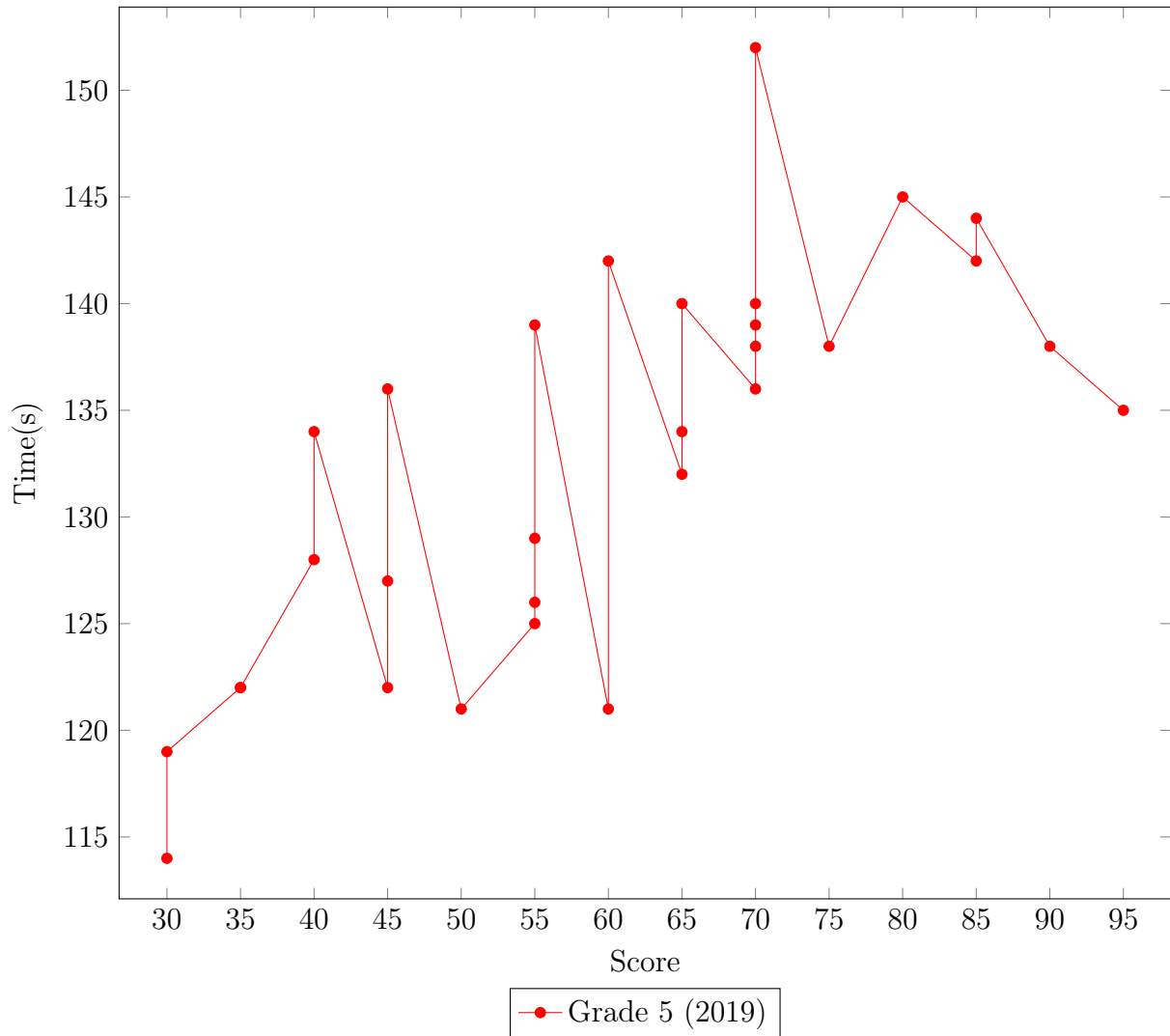
The graph above shows data acquired from both sessions of the grade 5 class in 2019. The overall feedback about the game from this class was that they found it to be mostly easy but they did find the last level to be challenging, this last level is where they spent most time even though it is the shortest level in the game. The results the children obtained seem to confirm the feedback they gave. There were a few children who seemed to not show interest though overall the class achieved high scores and showed a high rate of engagement. According to Tu, Sujo-Montes, and Yen, 2015 it could be expected that some individuals will show less interest in gamified lessons as there are different motivation types that have to be taken into account when trying to create the most effective engagement experience. Here

is where the game could use some improvement as it currently can't be adjusted depending on gaming preferences.

This class had more experience with using fractions. They had completed the topic the previous year while they were in grade 4, and had to make use of fractions in other topics in grade 5. This additional experience of the topic could have provided this class with a better understanding of the concept of fractions, rather than just the repetitive drilling the grade 4 class had.
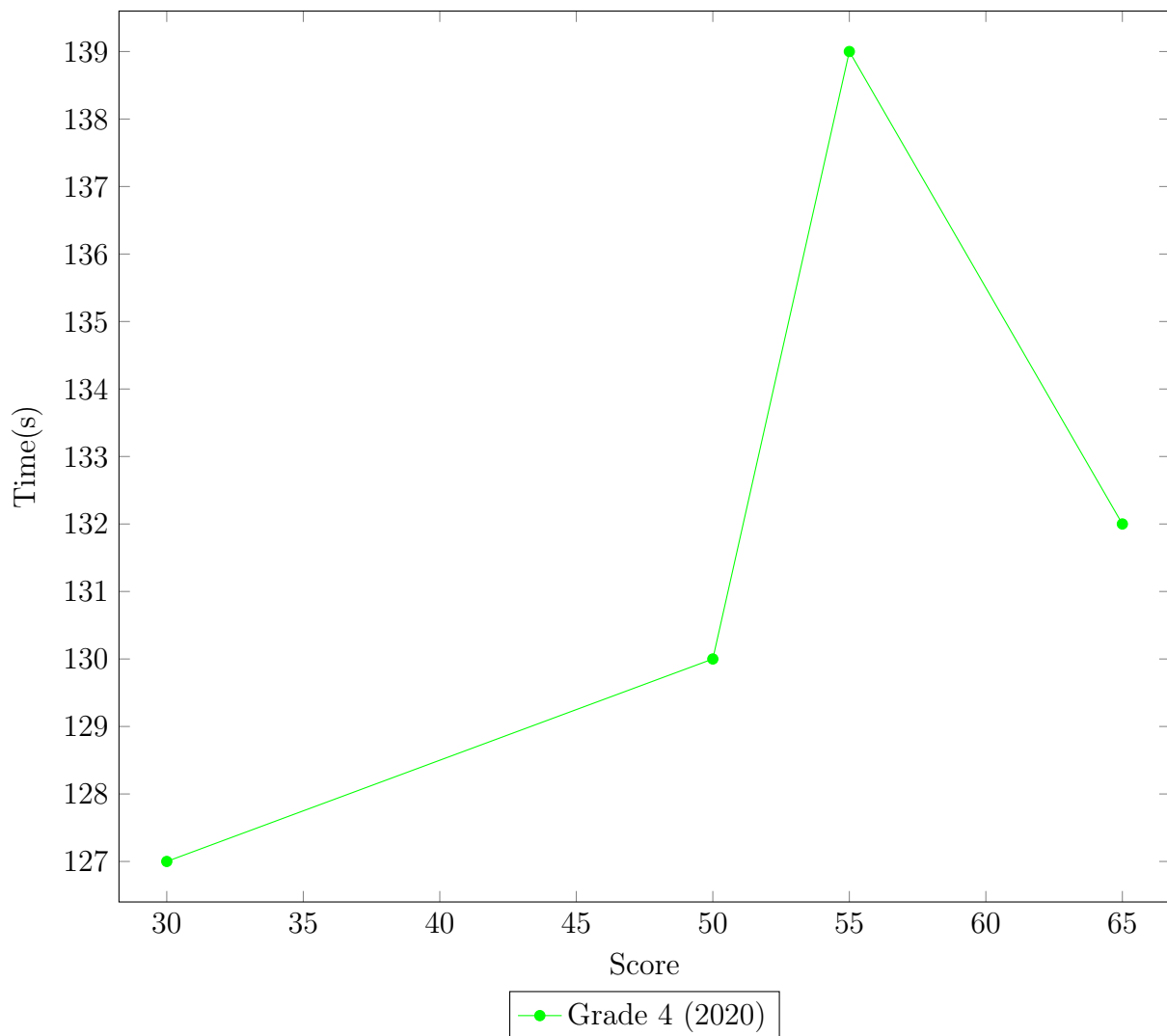
The graph above shows data acquired from 4 boys of the grade 4 class in 2020. The feed-

back received from the boys was that it started off easy and became difficult as the levels progressed, their feedback was almost identical to that of the grade 4 class from the previous year. The results they achieved also reflect their feedback as although they did take their time playing the game they achieved low to medium scores.

The experience these boys had with fractions is the same as that of the grade 4 class from the previous year. Although these boys where under different conditions to those of the classes from previous years, their results are still similar to the results achieved by the grade 4 class from the previous year.

4.1.2   Qualitative Data

The teacher was asked to take photos of the children through out each session. These photos provided some interesting insights on the behaviours the children were showing while playing the game. Considering that the game is an educational game on fractions that children could find boring (Wang, Shang, Briody, et al., 2011), proper gamification design was followed as much as possible when developing the game in order to keep the children focused on playing. The Tu, Sujo-Montes, and Yen, 2015 model on effective gamification design was used for this purpose.

Through out the game, most children were noticeably focused on playing. They read the questions carefully and took their time answering each one. Below are photos that show this.


Figure 4.1 Children focused on playing the game

Figure 4.2 Another group of children playing the game

This behaviour is one that was sought after as a result of effective gamification design. Player engagement is one of the four dimensions of the Tu, Sujo-Montes, and Yen, 2015 model on effective gamification design that was used when creating this game. This behaviour was also noticed when children started forming groups trying to work out questions together.
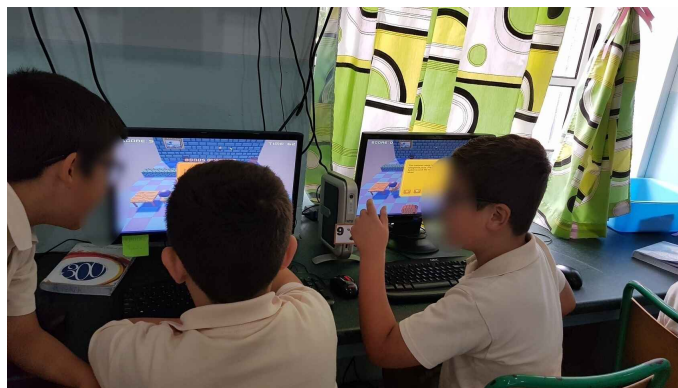
Figure 4.3 Children working together

In most cases the player engagement reached the level that was that was sought after, the game over all performed well. There were a couple of children from each class that did not engage with the game much which means that although the game performed well it still could use some improvement. One such improvement could be the implementation of difficulty settings.

After all 5 of the sessions were completed, the teacher who was in charge of all of them was asked a set of questions on what she thought about the game and the potential of gamification

Figure 4.4 Another group of children working together

being used more often in classrooms in the future. The interaction was as follows (names have been removed for data protection):

Question: From observing the children, how was the overall experience and did they enjoy using this game to revise fractions?

The teacher replied positively saying that the children were fixed on the game for the duration of their session. She jokingly said how if a game like this was given to children to play as homework or to use from home to study, they would start teaching the subject themselves.

Question: At any point during the sessions was there any sense of competitiveness between some of the children?

The teacher confirmed that she did notice children behaving competitively, and she also noticed a lot of teamwork too. Some children were moving places during the session to look at a friends question and work it out together. She was keeping an eye out for this type of behaviour and managed to take some photos of it.

Question: Would it be beneficial for games like this to become a mainstream part of classroom teaching?

The teacher confirmed that a game like this would really improve the class room environment in a way that would make lessons much more fun and engaging for students. She mentioned that these types of educational games being used in class rooms could even improve the engagement of students that find it difficult to focus. Another point she gave is that if these

games were given to the students to play as their homework exercises that could cause a significant improvement in their understanding of the topic.

Question: After having used the game in class, are there any changes or additions that would improve the game?

The teacher noted that the game had a couple of spelling mistakes in some of the questions that should be fixed. Another note is that the questions asked in the first level seemed to be asked more than once sometimes, it would be much better if this is avoided. Lastly she said that level 2 was a little short only having 3 questions.

4.2   Prototypes Performance

The prototype was created using ideas from the effective gamification model created by Tu, Sujo-Montes, and Yen, 2015, and with regards to these ideas the prototype seemed to perform well during the sessions as described by the points below.

- The goal of the activity was for students to experience a sense of competition between each other to see who can achieve to most points. This competition was sought after as it increases the children's motivation and drives them to play the game more helping them with practicing the topic. Further use of the game will result in them getting better at the topic of fractions, achieving the highest score in the game which result in the children gaining a better understanding of the topic. In this regard the prototype managed to perform well as children were competing among themselves during the session to see who could get the highest score from their friend group. They were even playing the game multiple times attempting to beat their previous score. After having tested the prototype in multiple classroom sessions, the children were asked about the experience they had playing the game. The feedback was unanimously positive as children gave their individual opinions about how they enjoyed this type of lesson more than traditional lessons.

- The ultimate goal of the game is to help the students to gain a better understanding of the concepts of how fractions work. By using the game more the sessions showed that this is possible as the students quickly started performing better on the easier levels clearly showing that they knew how to divide the fractions of a pizza. With further use of the game it is possible that they understand the topic more thoroughly.

- In order to keep the students engaged with the game the mechanic used was that of the score and timer. As they answered questions correctly their scores increased, the more difficult the question they answered correctly, the more points they would receive.

This is what invoked and sustained competitive behaviours between the students. The students behaviours were monitored throughout the sessions, they were seen getting out of their place to go to where their friend was sitting and look at the score he achieved in order to compete with that. The game was successful on keeping the students engaged with it, though it was noted that there was still room for improvement through out all the sessions a handful of students seemed to be uninterested with playing. The player engagement could be improved by adding more motivational mechanics to the game such as the use of awarding badges to the user when milestones are reached.

- The game was made progressively challenging to keep it interesting. As the game progressed the answers got more and more difficult to answer, and they also awarded more points for each correct answer given. This helped to keep students motivated and engaged with the game. Here the prototype was visibly performing well as children were reading each question carefully taking their time to give their answer, this is even shown in the photos 4.1 and 4.2.

4.3   Session Summary

4.3.1   Grade 4 2019 sessions

The students who took part in these sessions had almost completed the fractions topic that is in the Maltese syllabus for grade 4. Through the repetitive drilling exercises they had in the classroom they knew how to work out basic fractions exercises but started to struggle when they came to problems that were phrased differently to what they were used to.

While playing the game they took their time answering each question. During the first part of each question in level 1 the students understood what size fractions the pictures represented as this was a similar question to what they were used to seeing in class. They found the bonus questions to be much more challenging as they were phrased differently

to what they would normally see in their text books, even though the working would be the same. During these questions some children were moving places to look at their friends scores before getting back to their games.

Once they arrived to level 2 they were all struggling to answer the questions as they were worded in a much trickier way. Without a good understanding of fractions these questions were too difficult for them and they were asking the teacher for help regularly. Once the teacher would re-word the question to them in a way that they were used to they seemed to understand how to work it out. This further shows how the repetitive drilling they were doing to learn the topic only helped them memorize how to answer questions from their text book rather than actually understand the topic.

Feedback received from the students tells us that they enjoyed these sessions and preferred if they could have more lessons like this rather than only having the traditional classroom lessons.

4.3.2   Grade 5 2019 sessions

The students who took part in these sessions completed the fractions topic that is in the Maltese syllabus for grade 4, and had more experience using fractions in other topics in grade 5. They had a better understanding of the topic as they had more experience with it rather than just the repetitive drilling done in grade 4.

They knew how to work out the questions of the first level much more easily than the grade 4s did, but they still needed to take their time to answer the bonus questions. Once they reached level 2 they also struggled to answer the questions and needed the teachers help to explain to them how these are the same questions they work out normally but worded differently.

This shows that although the grade 5 students had more experience with the topic, they still did not have an in depth understanding of it.

Feedback received from these students is similar to that of the grade 4 students they said they enjoyed the sessions would like to have more of them. They found the game to be good and would keep using it to practice the topic.

4.3.3   Grade 4 2020 sessions

Similarly to the grade 4 class of the previous year, the students who took part in these sessions had almost completed the fractions topic. They got through the first level easily though at time they needed prompts to help them understand how to work out the question. They found level 2 to be quite difficult because of the phrasing of the questions and required some help from the teacher to give an answer.

These sessions was different to the ones done in 2019 as they had to be done over video call since all schools were shut down. The game was played by the teacher running it on her laptop while sharing with a student in a video call. This limited the number of children that could participate to 4 as each child needed their own session to play the game.

When asked about the game the children gave positive feedback saying that they enjoyed playing it and would like it if more games like this are used in their lessons.

4.3.4   Overview

This study was conducted to identify whether gamification strategies could be used by grade 4 teachers along side traditional lessons, to help their students get a better understand of fractions.

Using gamification to increase the lessons engagement, will provide an effective way for the students understand difficult concepts more as they would be able to contextualise problems. Gamification will also help teachers understand what students are thinking by observing how they are playing the game and the logic they use before answering each question. When students complete paper-and-pencil seat work, genuine thinking about the fraction problem

is not ensured (Naiser, Wright, and Capraro, 2003).

4.4   Purpose of The Study

The purpose of this study was to examine to what extent gamification can help improve the learning process for children learning difficult maths topics. The study focused on observing the children's behaviour while they use the game, and comparing the results they obtain from using it with their performance in a traditional class room lesson. Results obtained and observations made during the sessions show promising signs about the positive effect properly implemented gamification can have on a classroom lesson.

Research Question 1: How can a simple game increase the rate of engagement of students with a specific mathematics topic?

Children have been hooked to screens for entertainment ever since advancements in technology were made (Chow, Woodford, and Maes, 2011). This can be utilised by creating computer games that are both entertaining, educational and engaging. Furthermore the increased competitiveness between students who want to achieve a higher game score would also contribute by serving as motivation for them to continue using the game, practicing and getting better at the topic.

Batanero, Burrill, and Reading, 2011 discusses how good teaching is not about making learning easy for the students but rather it is about making it active and engaging for them. Through proper gamification techniques a game could keep the students engaged with it for long periods of time, making them want to play repetitively which would serve as revision of the difficult topic. During the sessions the game showed to successfully do this. This could enhance the educational experience by having games like this be used more often in the classroom. This would keep the students engaged in the lesson more, and would help students with difficult to understand topics by providing more context to them through scenarios provided in the game.

In their findings Wang, Shang, Briody, et al., 2011 show evidence that using games could greatly promote children's motivation to learn and reduce anxiety in classrooms. The sessions carried out at De La Salle while playing 'Recipe Fractions' clearly mirrored these findings as the same was seen with the children involved.

During the sessions the game showed to successfully keep most of the students engaged with it till they finished it, many students even chose to replay it to get better results. There could be some improvements as some children seemed to be uninterested with playing, this could be the addition of milestones and other such mechanics to make the game more engaging. Having the students be engaged with the game sufficiently would mean they are engaging with the mathematics topic, revising it in more context than that found in their text books.

Research Question 2: How can computer game technologies be leveraged in a grade 4 classroom to enhance the educational experience?

The game needs to be created following established gamification guidelines. If this is done properly then the game could be one that holds the children's attention and provides educational information that would have otherwise been gained through a lesson. The guidelines followed for the creation of this prototype were those made by Tu, Sujo-Montes, and Yen, 2015.

The answers provided by the teacher who was involved in the sessions further emphasise the extent that educational games can be used at to help improve the educational experience for students.

Moursund, 2006 mentions that it is a possible future where text books are replaced by games. Multiple reasons are mentioned such as reduced cost of students having to buy so many text books and improved health in the form of documented back problems from carrying so many books. These are factors that contribute to a possible enhanced educational experience for the students.

A teaching with games project was carried out over a year by Sandford, Ulicsak, and Facer, 2006. In their findings they showed how teachers with low IT knowledge found these games

to be substantially helpful through out the year long project. The teachers in this project pointed out how the students found the games to be motivational and engaging which greatly boosted the educational experience in their classrooms.

The teacher who was involved in the sessions mentioned how the students were really focused on playing the game, competing with their friends and enjoying the experience through out which is a sight she had not seen before when working on this topic in class in their usual environment.

Research Question 3: How can computers be used in the classroom environment to help teachers more easily teach difficult subjects to children?

The main issue with teaching difficult topics to students are providing necessary context in an understandable way that will help the students grasp the concept (Davis and Maher, 1990). Traditionally students are thought through the use of algorithms without grounding the concepts in a contextual basis. Due to this students who work out problems manage to do so through repetitive drilling rather than having an understanding of the logic behind the solution (Davis and Maher, 1990). Educational computer games can be used here as a tool for the teacher to provide that context to the students and help to improve the educational experience. The teacher who was involved in the sessions mentioned how using educational computer games could be an advantageous for them as it could even decrease the time required to spend on difficult maths topics, ensuring that the yearly curriculum is completed in time.

A computer game can help to provide better scenarios to help explain abstract maths topics such as fractions. Budoff and Quinlan, 1964 explains how it is easier for children to learn through visual representation rather than just white board explanation. This can be easily provided through educational computer games. This can help the children quantify concepts such as fractions by seeing what those fractions represent.

Using games helps to promote students' enthusiasm to learn and practice maths, participants broadly agree that playing games can help them focus and spend more time on practicing a

topic. 84% of the children who took part in these sessions strongly agreed that playing this style of educational games can help their studies by keeping them focused for longer than when using books.

Randel et al., 1992 explains this finding where 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. This clearly shows that educational games could be a huge benefit to teachers and a great tool to use to explain concepts that are difficult to teach to students more easily.

The teacher who was involved in the sessions also mentioned that using well made educational games could eventually become part of mainstream class room teaching considering how they clearly improve the engagement of all students, including those who usually struggle with focusing.