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Assessing the impact of digital games-based learning on students' performance in learning fractions using (ABACUS) software application

Adeeb M. Jarrah [1], Haneen Almassri [2], Jason D. Johnson [1], Yousef Wardat [3*]

[1] Emirates College for Advanced Education, Abu Dhabi, UAE
[2] Al Dhafra Private School, Al Ain, UAE
[3] Higher Colleges of Technology, Al Ain, Abu Dhabi, UAE

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Abstract

The United Arab Emirates' vision of the 2021 National agenda aimed that its students rank among the best in the world in mathematics and the sciences. However, fractions remain a challenging topic for both teachers and students. The purpose of this study was to investigate the impact of using digital games-based learning (ABACUS) on students' performance as they learn fractions. A quasi-experimental design was used in carrying out the research. All groups were pre- and post-tested to evaluate the effectiveness of the ABACUS active learning intervention. Eighty (n=80) student participants were divided randomly into a control (n=39) group and an experimental (n=41) group. Descriptive and inferential statistics were used to analyze the data from the pre- and post-tests. The results suggested that students in the post-test of the experimental group achieved a higher score than those in the control group. The findings of this study may provide mathematics teachers with an alternative method to teaching the concept of fractions. Additionally, the findings may also inspire or encourage curriculum planners to integrate digital games-based learning in educational settings. The study concluded with some implications and recommendations for future research.

Keywords: game-based learning, ABACUS, fraction, active learning, performance

INTRODUCTION

Computer games are becoming part of children's lives and their home culture environment. Individuals around the globe including children in the United Arab Emirates (UAE) use electronic devices daily. While digital games (DG) are being used mostly for entertainment, educators believe that DG is a powerful tool for mastering numerous skills as well. Yigit (2007), as cited in Ocaki and Akkas Baysal (2019), mentioned that the advancements in the field of science and technology greatly influence our lifestyle, impact our lives, and cause changes in every aspect; this development also affects the methods of teaching and learning.

Children's increased keenness to play electronic games has rendered the use of such games a popular topic. One study, Sabirli and Coklar (2020), which explored the impact of educational games in students' academic success indicated that including digital educational games increases students' access to the lesson and this leads to a significant increase in students' performance (Jarrah et al., 2020). Therefore, adding DG to the lesson might increase the improvement of the student by inducing more motivation to play and thereby benefit more from the educational process. Anastasiadis et al. (2018) stated that the DG-based learning approach is considered an effective educational tool to facilitate and enhance the learning process by increasing motivation and student engagement.

Mathematics games-based learning contributed to higher level learning outcomes in the teaching process as compared with the traditional instructional methods (Tokac et al., 2019). For instance, Jagust et al. (2017) compared lessons of a non-gamified digital lesson with a gamified digital lesson using a live game. The results

✉ adeeb.jarrah@ecae.ac.ae ✉ 201870081@uaeu.ac.ae ✉ jason.johnson@ecae.ac.ae
✉ yousef_alwardat@yahoo.com **(*Correspondence)**

Contribution to the literature

- Mathematics teachers and education researchers consider that a core concept in mathematics is fractions; however, elementary students face numerous challenges in mastering it.
- ABACUS encourages students to work collaboratively and ask each other about different mathematical problems and how to solve problems to get more points and to move to the next level. This method encouraged them to study and learn independently. Providing students with the opportunity to study and work independently is an important goal of the learning process and ABACUS gives the students the opportunity to work and practice more independently.
- The findings of this study may inspire or encourage curriculum planners to integrate DG-based learning in educational settings.

showed that the gamified digital lesson had a positive effect on the students' motivation, and students seemed to focus on the given exercise for a longer period, thereby correctly completing more mathematical tasks (Stoica & Wardat, 2021). The authors also argued that students in a non-gamified environment were bored and solved a smaller number of tasks. DG promote the learning of mathematics problem-solving as stated by Dayo et al. (2020) concluding that the DG had a positive effect on the student achievement (Aloufi et al., 2021).

Many educators and researchers believe that a successful learning environment could be created by utilizing an exploratory approach to learning such as the constructivist learning approach. In this active learning approach (Abdallah & Wardat, 2021), learners construct knowledge rather than just passively take in information, thereby shifting the teacher's role from a lecturer to a facilitator. Constructivism is an approach of teaching and learning where the students combine newly gathered information with what they already know. It also encourages the learners to be independent learners by working independently and constructing their own knowledge onto pre-existing knowledge (Alarabi & Wardat, 2021). Researchers also argue that DG can be considered constructivist instructional materials because of their potential to promote student-centered opportunities and active learning environment (Nino & Evans, 2015).

Mathematics teachers and education researchers consider that a core concept in mathematics is fractions; however, elementary students face numerous challenges in mastering it (Fazio & Siegler, 2011; Wijaya, 2017). Moreover, they believe that it needs to be taught in creative and engaging ways as students use the concept of fractions every year throughout their school years and beyond (Jarrah et al., 2022).

In the last decade of the 20th century, technology gained popularity after the explosion of global technology. The current generation have lived their entire lives with access to technology and digital technology, which explains the importance of the technology in their lives. The literature reflects the effects of DG in the teaching and learning of mathematics. For instance, Byun and Joung (2018) reported the increase of DGBL studies since 2005. Their results showed that DGBL had a statistically positive effect on students' mathematical cognition. Additionally, Stohlmann (2019) reported that DGBL motivated engaged students in mathematical thinking and increased student performance. Martin (2018) also investigated the effect of DGBL on elementary students' mathematical achievement in five areas– symbols/concepts, computation, word problems, everyday mathematics, and attitude toward mathematics. Martin's results revealed that students in DGBL show enhanced growth in the five areas and that there is a positive effect regarding the use of DGBL.

Problem Statement

The current study plans to explore the impact of DGBL on student's performance in solving mathematical questions containing fractions. Researchers found it beneficial to teach fractions using DG. For instance, Gresalfi et al. (2018) reported that students who studied through the DGBL, were described to have enjoyed their time solving problems and asked for more games. Likewise, Zhang et al. (2020) stated that integrating DGBL in solving mathematical fraction problems for primary students increased the students' conceptual knowledge of fractions and showed increased achievement when solving questions with fractions (Tashtoush et al.,2022).

In a study about the effect of online and interactive games in teaching, Hamzah et al. (2019) reported that teaching using interactive games had positively increased students' interest in mathematics and showed that students could explore the mathematical concepts at their own pace and play the games during their leisure time at home or school which would result in students learning mathematical concepts in a fun and engaging learning environment.

Al Khateeb (2019) looked at the effect of mobile gaming in mathematical achievement in the 4th grade. The results indicated that the use of mobile games served as an effective educational support to the students in mathematics. Lazem and Jad (2017) conducted research in one of the rural areas in Egypt (Burg El-Arab City) populated by Bedouins to explore and show how the

Table 1. Distribution of students who participated in study

		Frequency	Percent (%)
Group	Experimental	41	51.3
	Control	39	48.8
Sex	Male	41	51.3
	Female	39	48.8
	Total	80	100.0

integration of the DG technology could help in learning challenging mathematics topics. By applying the digital game to support the memorization of multiplication, facts and the results showed that adding the games had a significant influence on the motivation of the students to learn and solve more problems. The authors also found that students enjoyed learning by having fun and were encouraged to learn independently.

The above summary and discussion reported results within the area of digital game-based learning. Thus, the main purpose of this study was to investigate the impact of DG-based learning on students' performance in learning fractions using the ABACUS software application. The study sought to answer the following two research questions:

1. What is the effect of using digital game-based learning on students' ability to use fractions in problem-solving?
2. Is there a difference between genders in the performance of digital game-based learning?

METHODOLOGY

As mentioned above, the purpose of this study is to investigate the effect of using digital game-based learning in teaching fractions in mathematics in Al Ain, UAE. Thus, a quantitative quasi-experimental design was adopted. A quasi-experimental design was decided to conform to the main objective of the study as it seeks to establish a cause-effect relationship between two or more variables (Mills & Gay, 2019).

Participants

The participants involved in this study were 41 males and 39 females for a total of (n=80) grade 5 students. The participants were divided into two groups:

1. **The experimental group:** Students were taught fraction addition and subtraction concepts using DG-based learning. The experimental group consisted of 21 male students and 20 female students–total of 41 students.
2. The control group: students were taught fraction addition and subtraction concepts using traditional teaching methods. The control group had 20 males and 19 females, a total of 39 students (**Table 1**).

Instrument

Pre- and post-tests were used to collect data and assess the intervention applied in this study. The pre- and post-test assessments were developed by seven expert teachers, two faculty members from United Arab Emirates University and five mathematics teachers familiar with grade 5 mathematics curricula. They were grades 5 and 6 mathematics teachers with extensive knowledge and expertise in teaching mathematics.

The panel of experts reviewed the test to determine its relevance and suitability for the objective of the study. Their suggestions were considered and incorporated into the test. The final version of the test consisted of fifteen different fraction problems. There were eight adding fraction problems with a denominator less than or equal to 12 (including unequal denominators, equal denominators, and mixed numbers) and seven subtraction questions with denominator less than or equal 12 (including unequal denominators, equal denominators, and mixed numbers).

To establish the reliability of the test, the test-retest technique was used. Specifically, a two-week pilot study was conducted with 20 students who were not included in the sample of the study. Participants in the pilot phase were from a school that has similar characteristic and follows same curriculum. Additionally, students who participated in the pilot phase had no interactions with participants un the main research. The same developed test was conducted on the pilot participants at two different points in time, beginning of the two-week and at the end. Then, the scores from the first and second times were correlated in order to evaluate the test for stability over time. By using Pearson's formula, the reliability coefficient of the test was calculated and found to be 0.95.

Procedure

Before the start of the implementation of the study, the researchers received local permission from the site administrators and the required approval for ethical research. The control group received the traditional way of learning fractions, while the experimental group were subjected to lessons prepared with the integration of ABACUS that contained digital games related to the lessons taught. The duration of the experimental and control groups lasted for three weeks. It is worth noting that the study lasted three weeks because that was the time length allocated to introduce and cover the concept of addition and subtraction of fractions.

Data Analysis

Skewness and Kurtosis tests were run on the data collected in accordance with West et al.'s (1995) recommendations to ensure that the data was normal and devoid of outliers. Skewness testing, the outcome, which might be either good or negative, should not be

Table 2. Difficulty and discrimination coefficient for each question in the test

Item #	DifC	DisC
Q1	0.60	.46(*)
Q2	0.65	.57(**)
Q3	0.40	.53(*)
Q4	0.60	.48(*)
Q5	0.75	.82(**)
Q6	0.55	.55(*)
Q7	0.65	.57(**)
Q8	0.50	.43(*)
Q9	0.65	.62(**)
Q10	0.70	.91(**)
Q11	0.55	.41(*)
Q12	0.65	.57(**)
Q13	0.40	.53(*)
Q14	0.65	.62(**)
Q15	0.70	.91(**)

Note. *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed); DifC: Difficulty coefficients; & DisC: Discrimination coefficients

greater than two, in contrast, the Kurtosis test score should be less than seven.

To determine if there was any impact of using ABACUS on student performance, the students completed a pre-test prior to beginning the unit and the post-test after the concepts were taught. To analyze the data from the pre and post-tests on student performance, both descriptive statistics and inferential statistics were used to generate meaningful information from the raw data. The descriptive statistics included the standard deviation and mean scores on both tests. To answer the research questions, a t-test was used to determine if there was any significant difference between the experimental and the control groups. For all statistical analysis, the SPSS version 26 was used.

To determine the difficulty level of the items in the pre- and post-test, the difficulty and discrimination coefficients for the test items were calculated. Specifically, the percentage of students with wrong answers were considered as difficulty coefficients for each item, while the discrimination coefficients for each item was calculated as the correlation coefficient between each item with the total score.

Table 2 shows the difficulty coefficients and discrimination coefficients for each of the test items. **Table 2** indicates that the item difficulty coefficients ranged between (0.40-0.75), and the discrimination coefficients ranged between (0.41-0.91). Ideal multiple-choice questions have a difficulty coefficient of 30% to 80% and a discrimination coefficient of over 39% (Worthen et al., 1999). Thus, the extent of the difficulty of the test items and the discrimination coefficients were considered acceptable.

RESULTS

This investigation was to find out if the digital games-based learning had an impact on the performance of the students in grade 5 in solving fraction problems. This study assessed the difference, if any, between the test scores of the students who used the digital games-based learning and those who used the traditional way of learning mathematics. Additionally, the study investigated whether there is a significant difference between the results of the post-test between the genders.

Analysis of Research Questions

Question 1: What is the effect of using digital games-based learning on students' performance in fraction problem-solving?

To answer this question, means and standard deviations of the two groups for the method of teaching (DG-based learning vs. traditional instruction) were used and t-tests were used to identify any significant differences between both groups of the study, as shown in **Table 3**.

Table 3 shows the results for the comparison of performance between the means of both groups on the post fraction problem solving assessment. There were statistically significant differences between scores in favor of the experimental group (experimental: mean=11.93, SD=1.73; control: mean=9.90, SD=1.87) and p=0.000<0.05 (two-tailed).

Furthermore, in order to investigate the level of impact of the treatment on the experimental group, the effect size was calculated. Specifically, Cohen's d was used to demonstrate the size of the experimental effect: Cohen's d=(11.93-9.9)/1.807798=1.12.

A commonly used interpretation of Cohen's d (effect sizes) is based on benchmarks suggested by Jacob Cohen in 1969. Cohen's suggested benchmarks as small, medium, or large based on d=0.2 (small), d=0.5 (medium) and d=0.8 or larger (large). That means the effect size of d=1.12 is large showing that the intervention had a large effect on students' achievement in post-test experimental group compared to the control group.

Question 2: Is there a difference in the performance in digital games-based learning between genders?

As shown in **Table 4**, the results for the comparison of performance between male and female students showed that there were no statistically significant differences between scores (male: mean=5.33, SD=1.77; female: mean=5.30, SD=2.17) and p=0.957>0.05 (two-tailed).

T-test was suitable analysis measure even the sample size was less than 30 in each group because the effect size was calculated and considered to be large (de Winter,

Table 3. Means, standard deviation, & t-test results of experimental & control groups on post fraction problem-solving test (gender variables)

	Gender	n	Mean	Standard deviation	t	df	Sig. (2-tailed)
Post-test	Male	21	5.33	1.770	.054	39	.957
	Female	20	5.30	2.179			

Table 4. Means, standard deviation, & t-test results of experimental & control groups on post fraction problem-solving test

	Group	n	Mean	Standard deviation	t	df	Sig. (2-tailed)
Post-test	Experimental	41	11.93	1.738	5.024	78	.000
	Control	39	9.90	1.875			

Figure 1. Students' overall mean total score in pre- & post-test

2013, p. 7). As was stated earlier, the effect size (Cohen's d) was 1.12 which is considered to be large according to the benchmarks suggested by Cohen (Kraft, 2020).

Summary of the Results

In order to check that the sample was homogenous, statistical investigation was applied to both experimental and control groups. The results of the pre-test showed that the mean and the standard deviation of scores for both groups were insignificant. As observed, the experimental group scores (M=5.24, SD=2.165) were almost equivalent to the control group scores (M=5.31, SD=2.261) and the t-test showed (t=-.129).

However, the results of student performance in the post-test, in the experimental group (learning through digital games) were higher compared to the control group, which followed the traditional teaching methodology. Specifically, the post-test result showed that the experimental group achieved a higher score (M=11.93, SD=1.738) than the control group (M=9.90, SD=1.875) on the overall score, in which the t-test score (t=5.024) showed a significant difference between the two groups.

The difference between male and female genders in the performance using the digital games-based learning were tested. The results of the male group (M=5.33, SD=1.770) and the results of the female group (M=5.30, SD=2.179) showed that there are no statistically significant differences at (α=.05) due to the gender variable.

DISCUSSION

The results of the analysis of the t-test on the performance of the students taught using ABACUS digital games-based learning and those taught using the traditional way using the worksheets and the pencil indicated a significant difference in results in favor of the students taught with ABACUS. These results were based on the performance of 80 students on a 15-item content test administrated twice: as a pre-test before teaching and then after the intervention of the ABACUS as a post test. Results from the pre-test showed that there was no significant difference between the performance of the two groups in terms of the total score on the test. This indicated that the results of the two groups were comparable before starting the experiment, and this showed that both groups were homogenous in terms of their understanding of the test objectives.

The comparison between the experimental and the control groups' performance on the post test results, which took place after teaching the experimental group used the ABACUS digital games-based learning, showed that the students who were taught by ABACUS achieved a higher average score (M=11.93, SD=1.738) compared to the control group results (M=9.90, SD=1.875). An independent samples t-test analysis showed that the difference in their achievements to be statically significant (t-test=5.024 p=0.000). Thus, it can be clearly indicated that the performance of the grade 5 students in solving fraction problems using the digital games in the selected school in Al Ain was enhanced due to the adoption of ABACUS active learn. It can be drawn that ABACUS had a positive impact on the students' performance in learning fractions as shown in **Figure 1**.

The possible reason for this finding could be that ABACUS enabled and motivated students in the experimental group to practice and solve fraction problem through digital games. ABACUS motivated the students to practice more through playing more games, so the students were motivated to solve more fraction question by using the games instead of practicing by solving on paper. The enjoyment while playing the games could be a factor that affects the performance of the students in the experimental group since that enjoyment while playing the game could result in solving more problems.

The three levels of each game in ABACUS makes it an effective site. The reward system gave the students in the experimental group the opportunity to practice more fraction problems with three different levels for each game. The students were scoring points whenever they solved a question, thereby increasing their points to collecting rewards from the ABACAS site, whereas the control group could not do the same. This would challenge the students in the experimental group to solve more questions to increase their points and at the same time move to the harder level to get more points. This would help them confirm the conceptual fraction lesson taught at the class and practiced by the games.

ABACUS gave the students an opportunity to learn independently through digital games. Students had the capability to explore more with ABACUS active learning, through the available digital resources to learn more about a specific mathematics fraction topic. The features of using ABACUS lay out the rewards available to the students and the points they could get whenever they solved more questions and the challenges they could meet while solving the questions. The more problems they solved, the more points they would get, and the more rewards they received, hence the more stimulated they would be to attempt completing all three levels of the game. As a result, their performance would improve, and they would be further encouraged to solve more questions. Similarly, Kim and Ke (2017) showed that there is a positive effect inclu1ding the DGBL in accordance with math learning. The results revealed that the digital games included the characteristic challenges, rewards, and integration of game play with learning content that could improve math achievement in the learning environment. While in the control group the teaching was limited to a few examples using the white board and worksheets with only the teacher's explanation and no digital resources and games to practice in the school or at home. Hence, the students were only listening to the teacher in the class and practiced using different questions on a photocopied worksheet; this affected the teaching and learning process negatively. The students felt bored after solving a few questions in the class and merely waited for the teacher to check their work.

The difference between the performance of male and female students regarding the digital games-based learning were tested. The results of the male group were (M=5.33, SD=1.770); the results of the female group were (M=5.30, SD=2.179). This showed that there are no statistically significant differences at (α=0.05) due to gender variable.

The results showed that regardless of gender, the resources and the strategies in teaching mathematics fractions is what affected the performance of both genders among grade 5 students. Chung and Chang (2017) stated that the attitude towards the digital game-based learning was found to be positive regardless of gender. The researcher agreed that there was no significant difference in the correlation in the learning achievements between genders.

On the other hand, Lowrie and Jorgensen (2011), who had different results concluded that women tend to have a lower learning achievement than men in digital games of a competitive nature. The main reason could be attributed to the digital games used in this study belongs to moderate style. The enjoyment, happiness, challenging levels, motivation, points, and rewards available for both the male and the female students help in encouraging both genders to practice more and to confirm the knowledge acquired through practicing using the games. This benefits the learners by helping them enhance their learning process and cognitive understanding regardless of their gender.

As noted from the findings in this study, the ABACUS digital games-based learning had a positive impact on student achievement. Additionally, digital resources were available on ABACUS with detailed lesson plans, the differentiated activities, and the digital games related to the fraction concept taught. The teacher could assign the game to be practiced by the students using the electronic devices in the class or at home, which had a positive effect in delivering the lesson and therefore improve their performance. This study showed that the use of the digital games in ABACUS affected the performance of the students positively, and it concluded that the possible factors affected the student's performance are enjoyment and happiness, challenges, motivation, points, and rewards through the digital games in ABACUS.

The high level of curiosity and engagement was observed by the researchers when students contacted mathematics teachers to ask for more games to be played to practice the fraction topics, as Giannakos (2013) mentioned that the enjoyment and the happiness while playing the game could play a very effective role in determining the knowledge acquired by the learner. Enjoyment and happiness are two important factors which show that the learners are solving more questions by playing more games at different levels. Allocating games through the ABACUS active learning strategy to the students gave the teacher an opportunity to check if the students were enjoying and happily solving different levels. This feature on ABACUS enabled the teachers to know the level of the students and the knowledge they acquired from practicing at school or at home using the games as agreed by Gresalfi et al. (2018). As stated in previous research, digital games promote the learning of mathematics problem-solving and show that the digital games have a positive effect on the student achievement as mentioned by Dayo et al. (2020).

In addition, enjoyment and happiness while playing the games in ABACUS increased the challenges and the effort to solve more problems with fractions. While

Figure 2. Game three levels

conducting the study, teachers observed how students were excited to practice more fraction problems by finishing the three differentiated levels in each fraction game to gain more points and therefore earn more rewards. Using ABACUS active learning provided the students with different levels to solve fraction problem starting with the bronze level, the silver level then the gold level where they can see the questions are becoming increasingly difficult with each level, but they are acquiring more points which enhanced in the learning process. This was obvious for the mathematics teachers when they observed that the students were eager to solve the assigned games with all the levels (bronze, silver, and gold) as mentioned in **Figure 2**.

The challenges the students faced in solving the question encouraged the students to try different methods to solve the questions when they were stuck. They sometimes asked their friends and shared their ideas to try solving the question. They even stated they used the internet to search for ways to solve the questions in order to get more points. This helped the students learn by doing and by using their prior knowledge to construct new knowledge in the new concepts learnt. These results are in line with the findings by Jazim et al. (2017) reporting that students should be actively involved in process of building their understanding, that knowledge is not only to be stored in the minds of students, but it should be constructed through active involvement in the learning process.

When students used the ABACUS active learning, they were more engaged in their own learning and more confident of their ability to solve more mathematical fraction problems. These results are in line with the findings reported by Huang and Huang (2015), who reported that the digital games significantly improved the low-achieving students' motivation and performance in the learning process. The motivation they gained through solving more games with different levels encouraged them to play more games and collect more points (Wardat et al., 2021).

As shown in **Figure 3** and **Figure 4**, the ABACUS active learning site offers points to be added to the students account whenever they solve a question or finish a specific level. The reward system included in digital games encourages the students to solve more difficult challenging questions and stay focused in their paly (Kim & Ke, 2017). Similarly, this idea is supported by Moon et al. (2011) who highlighted that reward points/system is one of the most important elements in game structure to stimulate more active learning and to help players sustain in gameplay. This supports the rewarding system available on ABACUS active learn.

As for teachers, the use of technology is a challenge, and many teachers are still not familiar with how to use it properly in their teaching methodology. ABACUS active learning provides teachers with completed lesson plans with the integration of the technology tool that suits each mathematics lesson. Because some teachers shy away from using technology in their teaching, it is important to train teachers on effective methods to ensure that they are capable of using the features ABACUS provides for teaching mathematics through the available digital tools. Demirbilek and Tamer (2010) suggested that the professional development training regarding introducing the educational computer games is crucial to change the mathematics teachers' attitude toward computer games. ABACUS active learning is an easy website for teachers to use.

In summary, the purpose of this study was to investigate the impact of the digital games-based learning ABACUS active learning on the student performance. The results showed there is a positive impact of ABACUS on students' learning of fraction concepts. The feature of the ABACUS website offers students with fun experience in a challenging and clear teaching methodology as Dele-Ajayi et al. (2019) believes that mathematical digital games can potentially bridge the gap between the practical knowledge and the theoretical understanding by presenting the educational mathematical concepts and their application in a clearer way to students.

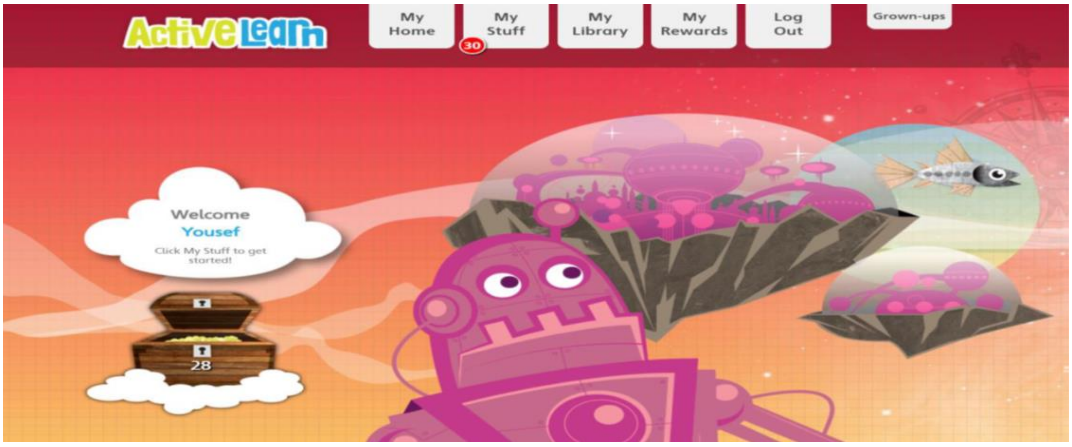

Figure 3. Student's account

Figure 4. Reward system

Recommendation and Suggestions for Further Research

As proved in many studies, including digital games in the mathematics lessons were productive for all elements of the learning and teaching process. A literature review showed that the implementation of the digital games to teach fractions had a positive effect on student performance in solving fraction problems and that the digital games encourage the students to play more and thereby solve more problems.

Being that this study concluded that teaching mathematics through the use of digital games affected the students' performance in solving mathematical fraction problems and increased the motivation of the students to solve more and acquiring more knowledge and ways in solving fraction problems, we recommend further exploration and implementation of digital games to teach mathematics in order for students to arrive at a firmer grasp of fractions.

Considering the findings of this study, teachers are encouraged to use the ABACUS active learning tool in their mathematics classes. Providing students with the opportunity to study and work independently is an important goal of the learning process and ABACUS gives the students the opportunity to work and practice more independently. Many schools are equipped with digital devices in class, and digital resources are available to enhance the teaching and learning process. However, teachers are reluctant to use these resources because of their lack of confidence using the devices or tools. The researchers recommend training the new teachers and teach them how to integrate the technology during their lessons and how to benefit from the digital resources such as ABACUS.

ABACUS encourages students to work collaboratively and ask each other about different mathematical problems and how to solve problems to get more points and to move to the next level. This method encouraged them to study and learn independently.

It is also recommended to investigate the effectiveness of training the teachers to use the ABACUS active learning on the student's performance. This further investigation will show if the teacher is confident about the use and the integration of the technology and assigning the suitable games for each lesson and how this could affect the students' performance during the teaching and learning process.

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