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THE IMPACT OF DIGITAL GAMES BASED LEARNING (ABACUS) ON STUDENTS' PERFORMANCE IN FRACTION FOR FIFTH GRADE STUDENTS IN AL-AIN

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This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Education (Curriculum and Instruction)

Under the Supervision of Dr. Adeeb Jarrah

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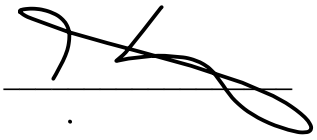
Declaration of Original Work

I, Haneen Mazen G. Almassri, the undersigned, the author of this thesis entitled "*The Impact of Digital Games Based Learning (ABACUS) on Students' Performance in Fraction for Fifth Grade Students in Al Ain*", hereby, solemnly declare that this thesis is my own original research work that has been done and prepared by me under the supervision of Dr. Adeeb Jarrah, in the College of Education at UAEU. This work has not previously been presented or published or formed the basis for the award of any academic degree, diploma or a similar title at this or any other university. Any materials borrowed from other sources (whether published or unpublished) and relied upon or included in my thesis have been properly cited and acknowledged in accordance with appropriate academic conventions. I further declare that there is no potential conflict of interest with respect to the research, data collection, authorship, presentation and/or publication of this thesis.

Student's Signature:  Date: May 3, 2021

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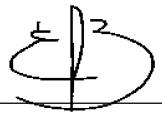
Signature  Date 18.4.2021

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Abstract

ABACUS active learn is an inclusive online site for teachers and students to illustrate and learn Mathematics in the primary level. ABACUS is considered as an online innovation that enables the students to have the ownership of their learning through interactive activities that can be done independently in the classroom or spend their rewards in online learning games. The main objective of this study is to examine the effect of using ABACUS on students' performance of 5^{th} grade while studying Fractions. This study designed to be tested in Al-Ain, United Arab Emirates. A quasi-experimental design was used to collect data using a pre-test and post-test tool to evaluate the effectiveness of the ABACUS active learn intervention. Eighty (n=80) participants were randomly divided into two groups of control and experimental. The results of the post- test indicated a statistically significant point of preference of using ABACUS digital based gamed learning for the experimental group over the control group. Specifically, results revealed that students who were exposed to ABACUS actively achieved a higher average score (M= 11.93, SD= 1.738) on the overall score compared to the score (M= 9.90, SD= 1.875) of students of the control group. The research finding will facilitate further researches on the use of the Active learning on teaching Mathematics. Additionally, it gives some recommendations for professional development for the implementation of ABACUS active learn in online learning for the primary Mathematics teachers.

Keywords: ABACUS, Fraction, Active learn, Performance.

Title and Abstract (in Arabic)

تاثير برنامج (ABACUS)على اداء طلاب الصف الخامس في حل مسائل الكسور بماده الرياضيات في منطقة العين

الملخص

يعتبر ABACUS عالم تعلم عبر الإنترنت يساعد في تعلم الرياضيات في المرحلة الابتدائية. يعتبر ABACUS ابتكارًا عبر الإنترنت يمكّن الأطفال من تولي مسؤولية التعلم ، ويمكنهم العمل على أنشطة تفاعلية بشكل مستقل في الفصل الدراسي ، أو إنفاق مكافآتهم في ألعاب التعلم عبر الإنترنت. الهدف الرئيسي من هذه الدراسة هو فحص تأثير استخدام ABACUS على أداء الطلاب في الكسور في ماده الرياضيات لطلاب الصف الخامس في العين ، الإمارات العربية المتحدة. تم استخدام تصميم شبه تجريبي لجمع البيانات باستخدام أداة الاختبار القبلي والبعدي لتقييم فعالية تدخل التعلم النشط ABACUS. تكونت عينة الدراسة من 80 طالبا من طلبة الصف الخامس تم تقسيمهم عشوائيا، وتوزعت هذه العينة على مجموعتين، مثلت احداهما المجموعة الضابطة، في حين مثلت الأخرى المجموعة التجريبية

أشارت نتائج الاختبار البعدي إلى وجود فروق ذات دلالة إحصائية في تفضيل استخدام التعلم المبني على الألعاب الرقمية ABACUS للمجموعة التجريبية على المجموعة الضابطة. على وجه التحديد ، كشفت النتائج أن الطلاب الذين تعرضوا للتعلم النشط ABACUS حصلوا على معدل أعلى اجماليا (المتوسط الحسابي= 11.93، الانحراف المعياري= 1.738) مقارنة للمجموعة الضابطة (المتوسط الحسابي= 9.9، الانحراف المعياري= 1.875). من المتوقع ان تساهم نتائج الدراسة في فتح أبواب دراسات أخرى متعلقة باستخدام التعلم النشط في تدريس الرياضيات. بالإضافة إلى أنها ستقدم بعض التوصيات المتعلقة بالتطوير المهني لتنفيذ التعلم النشط ABACUS في التعلم عبر الإنترنت لمعلمي الرياضيات الابتدائية.

مفاهيم البحث الرئيسية: العداد ، الكسر ، التعلم النشط ، الأداء.

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Dedication

To my beloved parents, Family and colleagues

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List of Abbreviations

ABACUS	Abundant Beads, Addition and Calculation Utility System
DG	Digital Games
DGBL	Digital Games Based Learning
GBL	Game-Based Learning
I Pads	Interactive Personal Application Device
ICT	Information and Communication Technology
NCTM	National Council of Teachers of Mathematics
NDP	New Zealand Numeracy Development Projects
PC	Personal Computer
SPSS	Statistical Package for the Social Science
STEM	Science, Technology, Engineering, and Mathematics
TOMA	Test of Mathematical Ability
TPC	Tablet Personal Computer
UAE	United Arab Emirates
UK Curriculum	United Kingdom Curriculum

Chapter 1: Introduction

1.1 Overview

This chapter gives an introduction of the thesis. It contains a general background about using technology in life and in education and the purpose of this study, which is about investigating the effect of using Digital Games Based Learning in adding and subtracting fractions in Mathematics on fifth grade student's performance. This chapter presented the statement of the problem which is about the performance of grade five students in solving mathematical problems. Moreover, it illustrates the significance of the study for students, teachers, and stakeholders. This chapter also shows the research questions, research definition of terms, limitation, and assumption of the study.

Computer Games in Real Life

Computer games are becoming part of children's life and their culture environment. Electronic devices are used by individuals around the globe including children in the United Arab Emirates (UAE). 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 affect the ways of teaching and learning. Digital games can easily be installed in the digital devices and the parents also could be apart in sharing the games with their children. Many games allow the parent and family members to participate and share the entertainment and learning through the integrational digital

games. Rice et al. (2013) believes that the integrational digital games enhance a positive interdependence that facilitate the social interaction, sharing and playing games increases the reaction that smooth the social reaction between the children.

Students can learn and learn from their family members when they use the integrational digital games by sharing the ideas from different aspects as the researchers Siyahhan, Barab and downton (2010) stated that integrational digital games play a positive role in engaging the players by increasing their interest. Digital games give the opportunity for players to discover their skills and knowledge from their family members. (Brougere, 2015, as cited in Dos Santos et al., 2019) indicated that the emergence of digital games have further contributed to the increase of complexity and the enhancement of creativity. Thus, researchers and educators have realized the potential of digital games in the teaching and learning processes. Many Digital games enhance the creativity among the young children as Behnamnia, Kamsin and Ismail (2020) believe that the DGBL has an active and positive effect on strengthening the children's creative thinking, the design of the digital game supports the children creativity.

Computer Games in Education

The use of games is becoming one of the hottest topics since the motivation in playing games has increased between the children as mentioned by the researchers Sabirli and Coklar (2020) that including the digital educational games increased the students access to the lesson and this leads to a significant increase on students' performance, so adding the digital games to the lesson might change the progress of the students by having them more motivated and wanting to play more and gain more in education process, as agreed by Anastasiadis, Lampropoulos and Siakas (2018) that

digital games based learning approach is considered as an effective educational tool to facilitate and enhance the learning process and increase the learning motivation and engagement on the teaching and learning process.

Technology has become an integral part of our educational system around the world. Students use technology to learn through explore, experiment and interactive games. The learning done through these have a greater and long-lasting impact on students' knowledge and skill. Students have gained more hands-on experience on devices like Personal Computer (PCs), Tablets, Notebooks and smart phones applications. Though most of the academic year 2020-2021 had gone in virtual learning, students are still able to obtain almost similar learning experience and their learning has not diminished. These methods have also kept them motivated and helped them participate and perform better. Digital games-based learning had two major goals where the students enjoyed playing the games to have fun and at the same time the achievement would be affected through the learning process as mentioned by Tokarieva, Volkova and Harkusha (2019).

Hwang et al. (2012) mentioned that adding the instructions and the material they would cover a way of digital games and the motivation of the students will be more because of the enjoyable nature of the games. (Papastergiou, 2009 as cited in Sung and Hwang, 2013) the Digital Games Based Learning (DGBL) possesses significant potential for increasing students' motivation. Some researchers mentioned that games permit constructive situated experiential learning, which is enhanced by active experimentation and immersion in the game (Squire 2008; Hainey et al. 2011 as cited in Girard, Ecalle and Magnan, 2013). Games could be particularly useful for generating a deeper understanding of complex sitting as mentioned by Gros (2007), and the use of the digital games affects the traditional teaching and learning way and

changes the traditional classes to more active and dynamic through the technology and digital games (Dele-Ajayi et al., 2019)

As a result, technological innovations reveal a new generation of education tools designed to help students to learn in a non-traditional way. Today having the computers in the classroom is not enough to encourage the students. Therefore, teaching through games and stimulation has a potential to engage today's students who are the masters of multitasking through information and communication technologies. Also, computer games are found to be one of the most interesting and entertaining virtual environments and is an important strategy to support new approaches as a teaching tool for students.

Computer Games in Mathematics

Motivational techniques must be increased in an educational way and with the benefit of student learning so that they generate values and demands in their knowledge, interest in the skills they develop during education. Teachers must provide more positive motivation in the students inside and outside the learning context by giving productivity to the educational environment and at the same time strengthening the values in their teaching as mentioned by Alcivar, Quimi and Barberan (2020). Similarly, Huang et al. (2010b, 2013) agreed that the students are more motivated, and they would like to think more if they have the Mathematics problem solving presented by games.

Mathematics games-based learning contributed to higher learning gain in the teaching process as compared with the traditional instructional methods as mentioned by Tokac, Novak and Thompson (2019). As agreed by Jagušt et al. (2019) in a research conducted to compare between two lessons, a non-gamified digital lesson and a digital

lesson gamified using a live game and the results showed that the gamified digital lesson had a positive effect on the student's motivation and the student kept the focus on the given exercise for a longer period of time, thereby solving more mathematical tasks. In contract to the non-gamified environment students became bored and solved a smaller number of mathematical tasks. Digital games promote the learning of Mathematics problem-solving as stated by Dayo, Alvi and Asad (2020) that the digital games had a positive effect on the students' achievements.

The digital games are a part of everyday childhood, the digital games are being used to benefit the young people academically, (Dele-Ajayi et al., 2019) indicated that adding the digital games to the mathematical curriculum changed the attitude regarding Mathematics as a boring and difficult subject and improved the engagement of the students and the construction of their own mathematical knowledge. Similarly, Dayo, Alvi and Asad (2020) agreed that although the mathematical concepts are dry and difficult, the DGBL increased the student's interest and motivation to learn and to solve Mathematics problem solving without being anxious and frustrated.

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. Integrating the theorical understanding and enhancing the concepts by practicing by playing games increased the confidence with the students who are usually quiet and less responsive in the traditional classroom.

This study will show the effect of using the Digital Games Based Learning on students' performance, and the difference of the performance between the genders towards the use of digital games.

1.2 Problem Statement

Many students have difficulties in solving Fraction, as mentioned by Jordan et al. (2017) that within the Mathematics domain, fractions are problematic for many children, especially those with learning difficulties and disabilities. Mathematics teachers agree that teaching fractions can be complex and confusing, but solving fractions is a necessary skill for students to have as they get older, using the traditional way of teaching fractions in Mathematics by using worksheets, books, papers and pencils became a boring way to teach, the study conducted a new way of teaching fractions in Mathematics using the digital games. The investigation of this topic is motivated by the UAE vision of becoming one of the top countries in Mathematics, and this research attempts to find a new way to teach Mathematics to make it easier to the students.

1.3 Significance of the Study

UAE vision 2021 National agenda has a target that the students rank among the best in the world in reading Mathematics and Science. Many students have difficulties solving fraction in Mathematics. The difficulties of solving Mathematics has motivated the researcher to conduct this study that may add to the literature in this field and may provide some insights and recommendation to the Mathematics Leaders and teachers in UAE to observe the influence of including the digital games-based learning in teaching fraction and its influence on the student's performance in solving fraction problems to enhance using the digital games in all elementary schools in UAE.

Another significance of current study is the lack of research available in UAE regards the integration of the digital games learning the Mathematics teaching

approach, and this study will present the influence of integrating the digital games in the Mathematics teaching and how this would affect the students' performance.

The availability of the technology devices with each student during this period of time and the use of the digital games and live resources with different subjects such as Science and English, this might be applied also to the mathematical lessons to approve the teaching approach and improve the students to construct the mathematical knowledge by themselves.

Another possible significance of current study is introducing the ABACUS innovation to the teachers in the local community, which may improve standards of teaching and learning Mathematics. The study may provide students with opportunity to explore new technologies in Mathematics. Furthermore, the findings of this study may help curriculum planners to recommend for more digital-games integration in the Mathematics curriculum in the UAE elementary schools.

1.4 Purpose of the Study

The purpose of this study is to find out if there is a statistical difference in the performance of the students who were using ABACUS and the students who were using the traditional way of teaching Fraction. The study will investigate the impact of using ABACUS digital games-based learning on the student's performance in solving Fraction. Additionally, the study will investigate if there is a statistical difference between genders performance who were using ABACUS digital learning.

1.5 Definitions of Terms

1. UAE: United Arab Emirates

2. DGBL: Digital Games Based Learning the new way used to teach student in this study.
3. Digital Games (D.G): games are used to learn mathematics using the electronic devices such as: (laptops, I-pads, Pcs)
4. ABACUS: Abundant Beads, Addition and Calculation Utility System

1.6 Research Questions

The main objective of the study is to gather results of fifth grade students solving Mathematics fraction problem using the Digital games-based learning compared to the result of fifth grade students who use the traditional way, the study will answer two main questions:

- What is the effect of using Digital Games Based Learning on students' performance in fraction problem-solving?
- Is there a difference in the performance towards digital games-based learning between genders?

1.7 Limitation of the Study

The context of this study is limited to the students and the teachers from the elementary level school in Alain private school, due to the small sample, it cannot be a representative to the whole school population in the UAE. So, this small sample will decrease the generalizability of the finding.

Chapter 2: Literature Review

2.1 Introduction

The purpose of this literature review is to provide background knowledge on information regarding the use of digital games in education. Therefore, for the purpose of this study, this literature review is divided into three sections: The effect of the Technology in educational classrooms, the influence of the Digital Games in education on students' performance, and the effect of the Digital Games in teaching and learning Mathematics on student's performance.

2.2 Theoretical Framework

Although the technology is essential as agreed by the NCTM (2000) by stating that, "Technology is essential in teaching and learning of Mathematics; it influences the Mathematics that is thought and enhances students' learning" (p.24) and students must learn Mathematics by understanding, actively building new knowledge from experience and practice. The effective Mathematics learning requires students' understanding from what they know and what they need to learn, and then challenge and support them to learn more.

Teachers and students should understand the role of the technology used in learning process Goos (2003) developed four metaphors to describe how technology can transform teaching and learning roles: master, servant, partner and extension. This study refers to use the technology as a partner when the teacher use technology to develop the mathematical understanding and extension when the students use the technology to practice Mathematics as agreed by Domingo and Garganté (2016) that the integration of the digital technology in the learning process facilitate the access to

information and increase the engagement to learn more and improve some aspects of learning practice.

Chaurasia (2020) mentioned that the ways of teaching learning process that facilitate the learners and provide them the learning experiences has been changed and he encouraged the self-learning and the constructivism approach in teaching Mathematics. The concept of self-learning and constructivism very related.

In today education system the teacher centered learning has been changed into a constructivism learning approach. In the constructivism learning approach, the individual are the ones who absorb and get the knowledge and the teacher is only facilitator in the classroom. Constructivism is an approach of teaching and learning where the students use new gathered information with what they already know. Constructivism approach encourages the learners to be an independent learner, when they practice independently and construct their own knowledge on the basis of their prior knowledge.

Fraction is one of the hardest topics which needs to be explained in a way that encourages the construct and builds more knowledge about the same topic every year in the learning process by themselves through practicing and solving more fraction problems.

ABACUS active learn gives the teachers an opportunity to be as a facilitator in the classroom by integrating the digital resources and assigning games to the students to play during the lesson at school or at home. Having this way of practice will give the students the chance to practice more and to construct their knowledge on the fraction topic.

(Major et al., 2012 as cited in Anwar and Rahmawati, 2017) believe that the knowledge construction is an active process, not a passive one. “The Math learning

which is based on constructivist theory provides the knowledge that is not only stored in the minds of students, but it should be constructed by the students through active involvement in learning process". (Anwar and Rahmawati, 2017). ABACUS in an active learning website with the presence of the technology in the classrooms as well as at home, which will raise the individual work and increase the knowledge constructed by the students in learning and exploring the fraction topic with the games practicing at all times.

Trinick and Stevenson (2005) found that the New Zealand Numeracy Development Projects (NDP) 2005 mentioned that the games are one type of activity used in the NDP to create a pleasant environment for effective classroom teaching. Lee (2012) mentioned that applying interactive computer games on learning fractions develops the fractional thinking of the students. Game-based learning (GBL) is one possible approach to teaching/learning that is supported by a constructivist experiential pedagogy as mentioned by Tokarieva, Volkova and Harkusha (2019). Using digital games learning to enhance students' performance could be done by making the students an independent learner and by giving them the change to construct their own knowledge and also to learn by themselves through digital games-based learning.

2.3 Review of the Literature

The impact of Technology in Educational Classrooms

Technology nowadays is an important topic, since the explosion of the global technology in the last decade of the 20th century. The recent generation have lived their entire lives with access to technology which shows the importance of the technology in our lives. While the digital technology such as the Tablet Personal Computer (TPC) becomes an important part of the school and it's used to facilitate the

student's learning process, a study implemented to check the student's acceptance of the TPC in classroom and the results showed that the students who used the TPC had the strongest positive direct influence. (Ifenthaler and Schweinbenz, 2016) similarly, Mango (2015) found that students enjoyed using the digital technology (iPads) and believed that the iPads helped them to learn, and they believed that the technology devices such as iPads facilitated their participation and collaboration in class. Similarly, Aldossry (2020) conducted an experimental study to measure the effectiveness of using the iPads with the tenth grade students' performance in Saudi Arabia by dividing the students into two groups, the treatment group used the iPads as a learning tool while the control group used the traditional method as a learning method, the research found that the iPads made a difference in students' Mathematics performance which was increased when students used the iPads as a learning tool and decreased with the group used the traditional way (paper and pencil), The researcher finalized that learning Mathematics concepts using the iPads provided an excellent opportunity for the students to study the subject, solve more Mathematics problems and the motivation they felt on solving through the iPads were increased.

Grigoryan (2020) agreed that using the iPads in teaching English to the beginners level language learners compared to teaching by papers and textbooks when he applied an experimental study in Dubai to compare between two groups of students, the experimental groups used the iPads and the controlled group used the papers and the textbook, the results showed that the progress of the experimental group in learning English was better, this study finalized that positive effect of using the iPads in learning process. Domingo and Garganté (2016) found that another digital technology such as: mobile technology in learning facilitating access to information and increasing engagement to learning and it improved in some aspects of learning practice. Whereas

Mirzajani et al. (2016) interviewed the teachers to check the factors that affected the motivation of the teachers to integrate the ICT during the lesson in the classroom and they finalized that they were trying to integrate the ICT as much as they know because of the insufficient technical support that discouraged teachers from using ICT in teaching. They admitted that the increasing adequate equipment and technical support in schools encouraged teachers to be capable to integrate the ICT properly during the lessons. Similarly, Liu et al. (2017) found that a teacher's experience with technology significantly influenced his or her classroom technology integration, access to technology in classrooms and the availability of quality technology support were related to classroom technology integration. The experience and the availability of the technology in the class influenced the learning process in a positive way.

Although students feel motivated through the specific use of technology in the classroom as mentioned by Francis (2017). The researcher intended that updating teaching techniques to better support inclusionary education as well as enhancing student motivation. Similarly, Corkett and Benevides (2015) agreed that the new teachers are more comfortable with the idea of integrating technology into their lessons after researching and completing a lesson plan focusing on the use of apps within an inclusive classroom. From the different literature reviews showed the impact of using different digital technology such as: I Pads and mobile devices during the classroom and the importance of the teacher experience in applying the digital technologies effectively during the lesson.

Digital Games Based Learning and the Students' Performance

This section shows the effect of the digital games-based learning in different fields in education and how this effects the performance of the students, A study

implemented in Southern Taiwan to compare between the use of computer games to learn and to use the traditional way to learn by using different computer games to measure the students' learning attitudes toward the nutrition course, the study lasted for four weeks with total sixty six, third graders in two classes of an elementary school, one class assigned as experimental group and the other assigned as a control group Yien et al. (2011) found that computer game-based instruction can effectively promote students' nutrition knowledge and improve the learning attitude of students on the experimental group as mentioned by Giannakos (2013) who studied the use of the digital games based learning in Norway as a factor that might affect the learners' performance by conducting an experimental study to check the factors of an educational game on the students' performance by assigning two different groups of students, the experimental group with 20 students were treated by a studying "Gem-Game" based learning for adding and subtracting integers, while the control group that consisted of 21 students were engaged in the traditional instructions. The researcher finalized that the enjoyment factor during solving the digital games had a significant positive effect on the learner's performance and he mentioned that the enjoyment could play a very influential role in determining the knowledge acquired by the learner.

Islamiyah, Setiawati and Utami (2020) studied the effect of use of the computer-based "color mixing maze game" it was used for Science learning activities through symbolic thinking skills in the experimental group compared to the paper based game used for the control group on the learning process by conducting a quantitative experimental research in one kindergarten school in Surabaya, Indonesia by assigning two groups, experimental group that consisted of 13 children and the control group that consisted of 10 children and the results showed that there was a significant difference in the effectiveness in computer based games compared to paper

based games to stimulate the scientific development knowledge on the children and that the digital games based learning provided the right understanding in the learning process and so it increased the children's cognitive abilities in the development of Science learning.

Another experiment study had been conducted on an elementary school Natural Science course to evaluate the effectiveness of a personalized game-based learning approach. The results finalized that the personalized educational computer game improves the learning achievements of the students (Hwang et al., 2012), Similarly to Su and Cheng (2013) found that mobile and gamification technologies could achieve a better learning achievement than using non-gamified mobile learning and traditional instruction by investigating how gamified learning approach influences Science learning achievement of the student using a Mobile Insect Learning System which is a gamified learning activity.

The authors Cheng and Su (2012) agreed that the learning achievements of students with game-based learning are better than those who use the traditional face-to-face teaching when they applied a quasi-experimental for system analysis course to evaluate the use of 3D game development tools and the course content corresponding to the game level content. Su and Cheng (2015) indicated that the Mobile Gamification Learning System in an elementary school Science curriculum incorporating mobile and gamification technologies into a botanical learning process could achieve a better learning performance and a higher degree of motivation. Whilst Khan, Ahmad and Malik (2017) argued that Games Based Learning application is an effective way to improve the performance and agreed that it was not equally effective for all students in the study that aimed to identify the impact of Games Based Learning on students learning in secondary school Science classrooms.

Several researchers studied the effect of digital games in teaching English on student's performance such as Hwang et al. (2017) who applied a quasi-experiment to indicate the students' learning behaviors in the problem-based English listening computer game where this study showed a significant higher result for the students who used the listening games compared to the students who did not use the listening game Similarly, Hashim, Rafiq and Md Yunus (2019) agreed on a study conducted to explore the effectiveness of using online language games to improve English as a Second language in the Asian countries, this study was done in a Malaysian secondary school to improve the students English grammar, pre post-test applied between two groups and the results showed that the experimental group used the digital games to practice English grammar showed better performance than the other group and the researcher finalized that the reason was the motivation to solve more through the learning process .

Huang and Huang (2015) stated that the digital games significantly improved the low-achieving students' motivation and performance in vocabulary learning since they conducted a research to study the effect of a handheld sensor-based vocabulary game based on a scaffolding strategy for improving students' motivation and achievement in vocabulary learning. The results showed a positive effect on student's achievement in learning vocabulary to learn a foreign language, similarly to Chen, Z., Chen, H. and Dai (2018) who conducted a study using the digital game (Planet Adventure) to improve reading and vocabulary of the student and the results were positive and it showed a significant positive effect on student's learning. This section reviewed the positive impact of applying the digital games in different subjects such as English and Science.

Digital Games in Teaching Mathematics and Student's Performance

Byun and Joung (2018) conducted a meta-analysis study to investigate the current trend of DGBL research in Mathematics education and how effective are digital games on students' Mathematics achievement in K–12 settings, the researchers have collected the studies related to DGBL in Mathematics education and published since 2000 and found that DGBL studies in the field of Mathematics education has been dramatically increasing in quantity since 2005, the results showed that the DGBL had a statistically positive effects on students' learning Mathematics. As agreed by Stohlmann (2019) the Games Based Learning motivated and engaged the students in mathematical thinking and the performance increased. By focusing on Science, technology, engineering, and Mathematics (STEM) program, Stohlmann investigated the STEM program by integrating the technology within Mathematics through games-based learning, he assigned a class of middle school to 4 weeks of Saturday STEM program, Desmos online graphing calculator were used in the study to integrate the games-based learning with Mathematics. Using the Desmos online graphing calculator finalized that the students were actively engaged in the game and they were able to make use of Mathematics aspects after several times playing games. Stohlmann (2019) found that Games Based Learning enabled the student to participate in productive straggle and improved the quality of students' solutions.

"The game-based learning environment directly focused on enhancing the adaptive arithmetic knowledge and skills, which is difficult to support in traditional classrooms teaching" (Brezovszky et al., 2019). This could help in the learning process and increase the student's playtime and increase the knowledge during integrating the digital games at school or assigning games to be practiced at home.

Hung, Huang and Hwang (2014) applied a quasi-experiment between two groups from the elementary school, to investigate the effect of games- based Mathematical learning on students learning achievement in comparison with the traditional instructions, by analyzing the pre and post-test, the results showed that the Mathematical game-based learning better promoted the students Mathematical learning outcomes than the traditional instructions model. Another game named Dream box a game-based learning investigated by Martin (2018) to test the effect of games-based learning on elementary students' Mathematics achievement in five Mathematical areas. The Mathematical symbols and concepts, computation, word problems, Mathematics in every day and attitude toward Mathematics for fourth grade. A quantitative study was applied through the Test of Mathematical Ability instrument (TOMA-3). Martin (2018) finalized the results and found that overall, the students treated with games-based learning showed enhance growth in the five areas tested and there is a positive effect regarding game-based learning.

Hashim, S. H., Hashim, S. and Ahmad (2019) conducted an experimental study with grade three students in four schools in Malaysia, where the students assigned to the study were the 'at-risk' students in Mathematics. In this study, students were taught through the games-based learning using the tables for solving Mathematics questions in Mathematics games apps as an intervention to enhance the performance of the students. The results proved the effectiveness of Mathematics-based game apps in helping the 'at-risk' students and improved the ability of the student in adding and subtracting concept. It was the same as what had been agreed by Hung, Sun and Yu (2015) that the effect of the of iPad app called Motion Mathematics: Hungry Fish – to help young students learn to theoretically understand and practically implement the mathematical concepts of addition and subtraction by giving the experimental group

challenging problems through the game and the control group by giving them matching games and they found that the students used this challenging game and achieved better learning performance than the students who did use the matching game, where the challenges through the games encouraged the students to solve more.

Teaching Fraction Problems Using Digital Games-Based Learning

This study will show the impact of Digital Games Based learning on student's performance in solving mathematical Fraction problems. Therefore, this part will show reviews of different authors regarding the effect of using of DGBL in solving Fraction problems.

The digital games-based learning encourages the students to play more and enjoy while solving mathematical problems. Gresalfi et al. (2018) compared between two groups of students, the first group used the digital games to solve different fraction problems and the second group used the worksheet to solve the same problems (fraction comparison and equivalence) for grade three, and the results showed the students who were using the games were enjoying their time solving and asked for more games, while the group that solved the worksheet were able to solve but without enjoying their work and after interviewing the students who used the games to solve fraction problems indicated that students noticed the Mathematics content in the games, sometimes linking it to the game mechanics, noticed the relevance of the game for the assessment and talked about enjoying the games and this could help in improving the performance of the students and the student's engagement.

Zhang et al. (2020) stated that the integrating the digital games in solving Mathematical fraction problems for the primary students increased the conceptual knowledge of fraction topics and showed that the students in the experimental group

were using the games-based learning achieved a better performance in solving fraction question in comparison to the control group who were receiving the traditional instruction. As agreed by Chang et al. (2015) who examined the use of the Digital game (The Mathematics App) in rural southwest Virginia, US for grades 6 -8 in solving Mathematical fraction problems. This study showed that the students in the game intervention group learnt fraction concepts and showed higher Mathematics proficiency than those in the paper-and-pencil group. Similarly, Aremu and Adebagbo (2019) in a primary school in Nigeria agreed that students exposed to digital Mathematical games in learning and practicing fraction performed significantly better than the students who studied in the traditional way.

Kiili et al. (2018) had another point of view, found that results supported the previous findings indicating that the game-based interventions emphasizing fraction magnitudes improved students' performance in conceptual fraction tasks for grade three students. Kiili and his team finalized that the game mechanics and the feedback that the game provided did not support conceptual change processes of students with low prior knowledge well enough and common fraction misconceptions still existed.

From Previous Studies

Rababah Nusair and AlHersh (2020) in Jordan conducted a research to investigate the effect of using the computerized visual games on learning letters and numbers and the visual perception skills for Jordanian Kindergarten Children in Irbid, 50 kindergarten children participated in this study by dividing them into two groups (experiment and control groups), the experimental group studied by the computerized visual games while the control group studied the traditional way, the results showed

that the computerized visual games had a significant impact on improving Jordanian kindergarten children visual perception and the ability to learn numbers and letters.

Al Khateeb (2019) conducted an experimental study to identify the effect of mobile gaming in Mathematical achievement among the 4th grade in Jordan by distributing 66 students over two groups, experimental and control groups, the experimental group was taught using the educational mobile games and the control group taught by the traditional method and the results showed that the use of mobile games had an effective educational support to the students in Mathematics, the effectiveness of using the mobile games in Mathematics was highly significant.

Hamzah, Maat and Iksan (2019) conducted a quantitative study used a quasi-experiment method from a primary school in Malaysia (Malacca), the researcher studied the effect of the online and interactive games in teaching coordinates for the year three students performance by assigning the online games in the teaching process for the experimental group while the controlled group relied on conventional classroom instructions, by comparing the pre and post-test between the experimental and controlled groups, the results showed that the experimental group had a higher mean score than the controlled group and results indicated that teaching using interactive games had positively increased students interest towards Mathematics and showed that students could explore the mathematical concepts of coordinates at their own pace and the students could play the games during their leisure time at home or school, Students could develop and build mathematical concepts in a fun learning environment.

Lazem and Jad (2017) conducted a research in one of the rural areas in Egypt (Burg El-Arab city) populated by Bedouins, The study was to explore and show how the integration of the digital games technology could help in learning challenging

Mathematics topics, by applying the digital game to support the memorizing multiplication facts, pre and posttest applied on a group of students and the results showed that adding the games had a significant influence on the motivation of the students to learn and solve more Mathematic problems, they also enjoyed learning by having fun, integrated games encouraged the students to learn independently.

2.4 Summary

The results of the previous studies supported the idea that the students are able to inspire themselves to learn and explore more in the topic they are learning by using the digital games through the lessons and at home. This study also shows some learning difficulties regarding the integration of the digital games in the teaching and learning process in the classroom and at home and suggest further strategies to improve the ways of teaching fraction problems in Mathematics. Other areas to be investigated in this area of study is how teachers connect the fraction Mathematics problems to the real-life situation and how to motivate the students to learn and explore Mathematics concepts by themselves.

Chapter 3: Methodology

3.1 Overview

Technology integration in the classrooms provide numerous advantages in supporting the learning process, Aldossry (2020) agreed that the inclusion of technology might affect positively on the students' performance by encouraging them to work and practice more and therefore, a better performance. The researcher suggested that the digital games-based learning through the electronic devices available with the students in the classroom or at home may enhance the process of constructing the new concepts of the lesson through the motivation solving more problems through playing games, and therefore the performance of the students may increase. Digital games could be an effective tool to enhance the learning process and this study will find out whether the implementation of the ABACUS digital games with the fraction problem solving, could help promote the learning process and positively affect the performance toward fraction.This chapter describes the research methodology that was used to answer the research questions designed to investigate the impact of digital games-based learning on students' performance in fraction for fifth grades in one of the private schools in Al Ain, United Arab Emirates.

Questions that guided this research study are:

1. What is the effect of using Digital Games Based Learning on students' performance in fraction problem-solving?
2. Is there a difference in the performance towards digital games-based learning between genders?

The purpose of this chapter is to describe the procedures to conduct the research. The chapter begins by providing detailed description about the context of the study, sampling and population selection, the research design, instruments to collect the data,

the validity and reliability of the test, procedure, ethical issues and the data analysis techniques.

3.2 Context of the Study

The study has been done in the first term of the academic year 2020-2021 with the total number of three teaching weeks. The study took place in a private school in Al Ain city in United Arab Emirates. The education system has two branches one in AL Ain and the other in Abu Dhabi. The school ranges from KG1 to 12. The Mathematics curriculum follows the UK academic Curriculum. The textbox used for Grade 5 is ABACUS by Kerwin and Merttens (2014) and published by PEARSON.

PEARSON has developed a complete teaching toolkit to support the learning process with over 10,000 resources, activities, plans and assessment tools, for ages 5-11 the have developed ABACUS as a unique primary Math toolkit, that's carefully designed to help in inspiring a genuine love of Math and help every child master mathematical concept filled with lively and exciting Math games and rewards and supportive textbooks and workbooks for independent practice.

3.3 Research Design

This study used a quantitative quasi-experimental design to investigate the effect of using the digital games-based learning in teaching fraction in Mathematics, which the participants were divided into two groups:

- The experimental group (1): students taught the fraction concept using the digital games-based learning, (N=41) contain classes girls (N=20) and boys (N=21)

- The control Group (2): students taught the fraction concept using the traditional teaching methods, (N=39) contain classes girls (N=19) and boys (N=20)
- The independent variable was the digital games Learning and the dependent measure were the student's performance.

The pre and post-test item for the mathematical test were developed along with Math experts, with its validity and reliability validated by the pilot study. The pre-test (Fraction questions) was given to the two groups to test the equivalency between the two groups before starting the study. After three weeks, the post-test was given to the two groups, in order to compare between the performances of the two groups after the implementation of the digital games-based learning.

3.4 Population and Participants

This research studied the effect of the digital games assigned to the students through ABACUS on the learning of fraction unit for the grade 5 students in the elementary school. The research site in this study is elementary and high school in Al Ain serving approximately 2777 students from 39 different countries. The sample of this study included 80 grade 5 students that included (41) boys and (39) girls. Twenty-one male students and twenty female students were in the experimental group and twenty male students and nineteen female students were on the control group. Two boys' sections and two girls' sections were selected. The participants have different nationalities and different gender (males and females). The researcher met with the students who participated in this study and clarified for them that this study will not affect them, and the purpose of the study is only to show the effect of the digital games-based learning and they were selected to be on this study. With response to research

ethics, formal consent to participate in this study were requested from both the participants and their parents.

Sample Distribution

This study has been applied into two groups the experimental and the control, and between the male and female, Table 1. below shows the distribution of both groups on this study, the students of the experimental group and the controlled group were divided into four different sections of grade five from the schools without the intervention of the researcher, this is why this research was considered to be a Quasi-experimental study, due to the non-random selection of the grade five students who participated in this study.

Table 1: Distribution of Students Who Participated in the 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

3.5 Instruments

The main objective of the study was to gather results of fifth grade students solving Mathematics fraction problems using the Digital games-based learning compared to the result of fifth grade students who used the traditional way, the two main research areas in finding if there is an effect of using Digital Games Based Learning on students' performance in fraction problem-solving and if there is a difference in the performance towards digital games-based learning between genders

and to attain the aims of the study the instruments utilized in this quantitative quasi-experimental study were a pre-posttest.

Pre-Test

In order to verify the equivalence of the two groups, the experimental group and control group before conducting the study, the two groups were given a pre-test in fraction problems provided by expert Mathematics teachers, the test consisted of 15 different fraction problems. There were eight adding fraction problems with denominator less than or equal 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). The evaluation of the pre-test was done through the provided model answer.

Post-Test

After three weeks of teaching two different groups solving fraction problems, one group was taught by using the digital game-based learning (ABACUS), and the other group was taught by traditional teaching methods. The two groups were given a post-test in the fraction content provided by expert Mathematics teachers, the test consisted of 15 different fraction problems. As mentioned earlier, there were eight adding fraction problems with denominator less than or equal 12 (including unequal denominators, equal denominators, and mixed numbers) and seven subtraction question with denominator less than or equal 12 (including unequal denominators, equal denominators, and mixed numbers). The evaluation of the post-test was done through the provided model answer.

3.6 Procedures

A 3-week teaching of fraction Mathematics problems unit on measured students' performance. A quasi-experimental design with two control groups and two experimental groups was used. In this study the dependent variable was the students' scores on the Mathematics fraction test. The independent variable was the use of ABACUS in the classroom and at home. All students participated in a pre-test in solving fraction problems, then the experimental groups were subjected to the lessons prepared with the integration of ABACUS that contained digitals games related to the lessons taught, while the control groups were subjected to the lessons formed with traditional way of teaching Mathematics. A post-test was applied to the four classes. The experimental group was treated with ABACUS digital games where the students could see how many points they earned at the end of each question and could solve differentiated questions through the three levels available in each game. Also, the treated group could collect points through the different levels on each game and at the end get rewards. Meanwhile, the control group did practice only by using the worksheet and specific amount of question prepared by the teacher.

The Mathematics teachers participated in this study followed the ABACUS lesson plan which includes all the important points to be explained to the students including the digital resources to be used in the classroom through the smart boards and by assigning digital games to be practiced by the students in the school or at home, the teachers participated on this experiment and had an excellent experience in using the ABACUS active learn site and integrated games related to the fraction lesson taught only to the experimental group. Whilst the same teachers excluded the digital resources and the digital games from the lesson taught to the control group by using

only the white board to explain and the photocopies worksheets to practice with the students in the classroom or independently at home.

Each class learnt this topic in 15 sessions, distributed over 3 weeks and, with each session lasting for 45 minutes. The same content was covered in each lesson for the four classes, with the only difference being that the control groups did not use ABACUS digital games, they only used the traditional way to explain using the white board to teach the fraction lessons and solving and practicing using worksheets prepared by the teacher without the integration of the digital resources and the digital games, while the experimental groups used the Mathematics ABACUS active learn in their learning where the teacher could use different digital resources to teach the fraction lessons and assigning digital games to the experimental group, where the students could play the games at school or from home, using the computer or the iPad. The experimental group could solve different levels with differentiated fraction questions, collecting points and getting rewards. All classes received the same assessments for this topic, which included class-work activities, quizzes and assignments. Then the scores on the pre-test and post-test were analysed to determine if there was any effect on student performance.

The Intervention: ABACUS

Detailed Lesson plan: ABACUS provides detailed lesson plans including the strand, main focus, objectives, prior knowledge, key vocabulary and the outcomes, the detailed lesson plan is formatted to guide the teacher to the proper way to explain the lesson with the integrated of the digital resources and games to support the ease the delivery the concept of the lesson to the students. A sample of ABACUS lesson plan see the Appendix.

Digital Resources: ABACUS active learn site provides a huge number of digital resources to be used in order to prepare the students for the main lesson. For example, the main focus of a lesson is to write improper fractions as mixed numbers and vice versa, ABACUS provides a digital tool to check the students prior knowledge which is related to the main focus and make them ready to understand the main concept, ABACUS provides a digital tool as shown in Figure 1 Clock Tool that is used to ensure that the students can read and understand mixed numbers and know how many of a given fraction make a whole one, Figure 2 Screen Tool is used to explain and ensure that the students can convert mixed numbers to improper fractions and vice versa. The teacher uses the digital resources, through the smart boards available in the classes. Those tools are used to check if the students the prior knowledge that is connected to the main focus of the lesson.

Figure 1: Clock Digital Tool

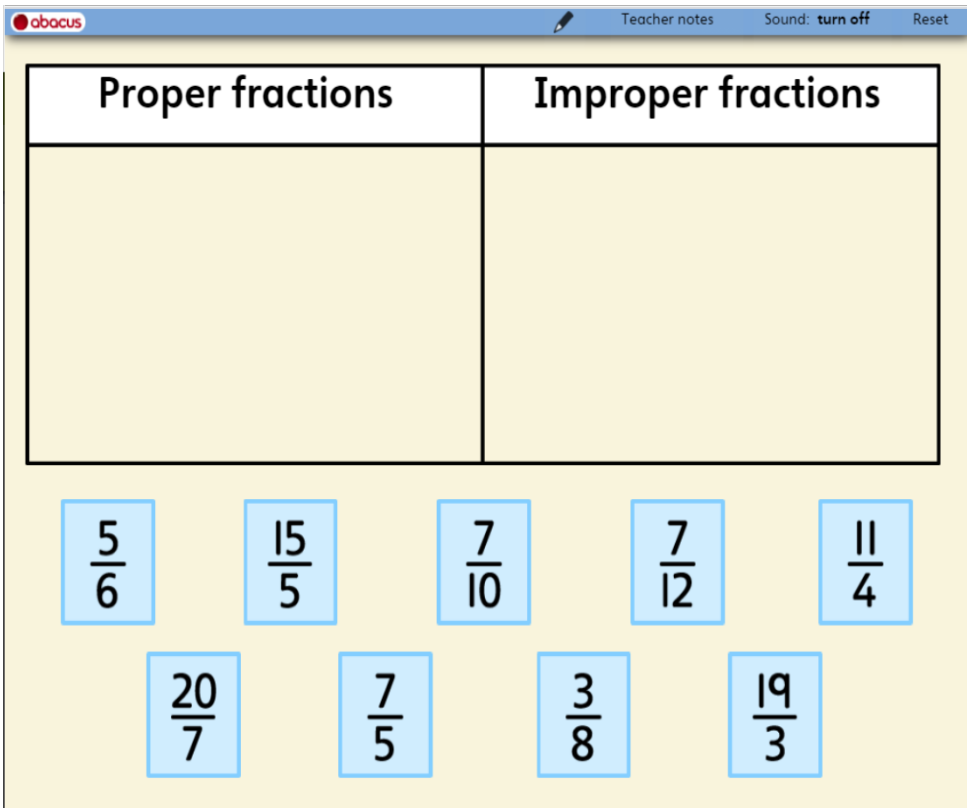

Figure 2: Screen Digital Tool

Independent Activities (Games): ABACUS active learn site provides the Mathematics teachers with different digital games related to the lesson explain. The teachers can allocate the related digital games to a specific grade section by allocating the game to the students account as shown in Figure 3 Allocate a Game, where the game will be available to the students to practice individually through the technology device available at home or in the school. Every assigned game is included three levels to be practiced individually as shown in Figure 4 Game Different Levels, whenever the student is done with solving a question, points will be added to his account, and whenever the students move from one level to another the question will get harder and the points will be increased regarding the level of the questions solved.

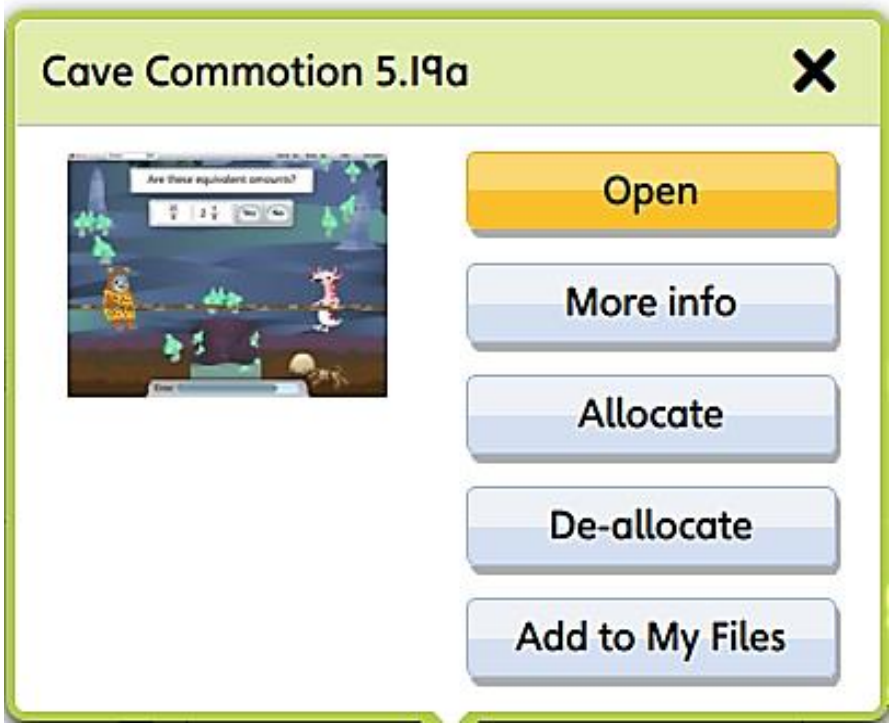

Figure 3: Allocate a Game

Figure 4: Game Different Levels

The instructions of the games on ABACUS are mentioned in a way that the students could hear the instructions by the features ABACUS had, also students can read the listed instructions before starting of the game as shown in Figure 5, the instructions are available in each game for the different levels. all games are available with attractive themes to grab the student's attention as shown in Figure 6.

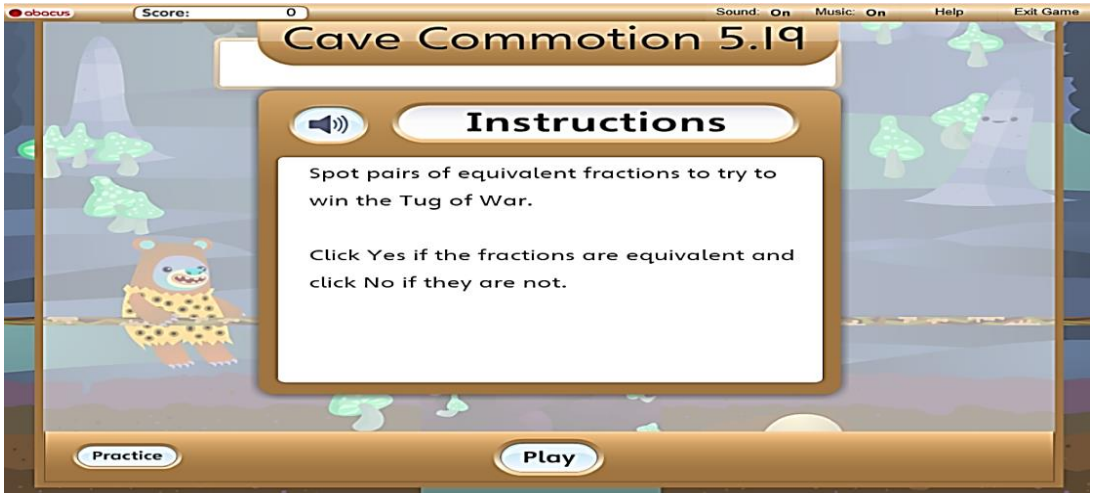

Figure 5: Game Instructions

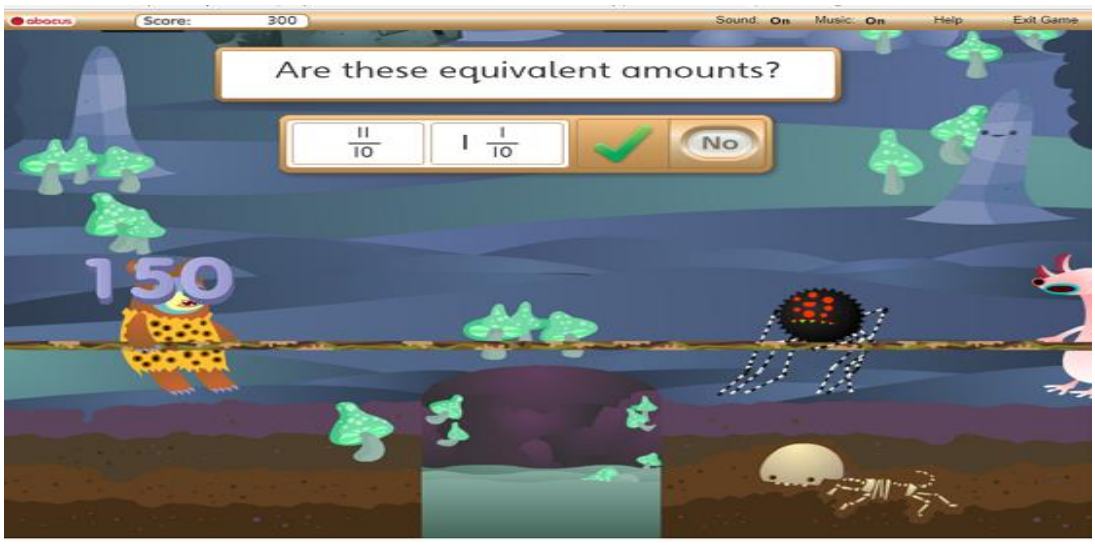

Figure 6: Game Theme

The Traditional way of teaching: The traditional way of teaching fractions using the white board to explain the lesson and the worksheets with different fraction problems to be practiced in the classroom or at home. The teacher and the researcher will exclude the digital resources and the individual digital games that have been used through the intervention. By only including the concept to be taught suing the white board and the worksheets.

3.7 Validity of the Test

Face validity of the test was established by distributing the test to 5 Mathematics teachers in Al Ain. The 5 teachers were grade 5 and 6 Mathematics teachers, who had extensive knowledge and expertise in Mathematics. The expert teachers suggested to edit, delete and add some items and their suggestion and feedback were taken into the researcher consideration before administering the test. The expert teachers suggested to change some of the questions which are not included in the unit taught on the assigned term. The teachers suggested to change the questions that included the denominators greater than 12 and suggested to only include the questions with the denominators < or = 12, they have mentioned that during the three weeks of the experimental study, grade five will study the addition and subtraction fractions for the denominators not greater than 12. And they have also suggested to add four to five picture fraction problems.

3.8 Reliability of the Test

To establish the reliability of the test, the test-retest technique was used. The test-retest was implemented by conducting a pilot study where a test was given to 20 students who were not included in the sample of the study. They sat for the test. Two

weeks later, the pilot group took the same test. By using Pearson's formula, the reliability coefficient of the test was calculated. It was found 0.95%. Thus, the test could be described as being reliable.

3.9 Ethical Considerations

For ethical considerations, this research was approved by the Office of Research Ethics Committee at UAE University. The researcher received the approval to conduct the research from the principal of the school, the Mathematics head of department and student's parents. A descriptive outline of the study, starting date, duration, participants, procedure, and the benefits of the study were sent to the school administration. During the implementation period, the researcher updated the Mathematics head of department with the students' participation and improvement. The participant students in the study were equally treated with the highest confidentially. Participants in the study signed consent form by their parents to allow the researcher to use their results as part of the study, Information about the study and its purpose was provided to participant and the parents before signing the consent letter. At the end of this study the students received clear information about their results in both pre- and post-tests. The consent form is attached in the Appendix.

3.10 Data Analysis

To determine if there was any impact of using ABACUS on student performance, the students completed a pre-test earlier to learning the unit. Students sat for the post-test after the concepts were taught. To analyse 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 were used to find the standard deviation and mean scores on both tests. A t-test was used to determine if there was any significant difference between the experimental and the control groups in order to answer the research questions.

3.11 Summary

This chapter discussed the methodology of the study, which is a quantitative quasi- experimental design. At the beginning of the chapter, the specification of the participants was presented including the academic cluster and their gender. The division of the two groups experimental and control group have been presented as well. Then after the description of the study participants, the study instruments were explained in details, the pre-test and post-test containing 15 different fraction questions. Both exams included questions related to the two aspects in fraction concept (addition and subtraction). The pre-test used to check the equivalency between the two groups before conducting the study. Validity and reliability of the test were tested and established. The procedure of the study was described, starting from the pre-test, followed by the intervention (applying the digital games-based learning with the experimental group), and the study ethical issues, and ended with the post-test and the results. SPSS has been used to analyze the results.

Chapter 4: Finding of the Study

4.1 Introduction

This chapter shows the results of the investigation that was carried out in the previous chapter. 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 in the test scores of the students who used the digital games-based learning with those who used the traditional way of learning mathematics. And the study showed if there is a significant difference between the results of the post text between the genders. This study used a pre-test that all the participants were tested on prior to participating on this study and a post-test was used after the completion of this experimental study. For all statistical analysis, SPSS was used.

4.2 Difficulty and Discrimination Coefficients (Test)

Using the (SPSS) program, the responses of the study sample were analyzed to calculate the difficulty and discrimination coefficients for the test items, where the percentage of students with wrong answers are 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: Difficulty and Discrimination Coefficient for Each of the Items Considered in the Test

Item #	Difficulty coefficients	Discrimination coefficients
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(**)

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

It is noticed from Table 2 that the item difficulty coefficients ranged between (0.40-0.75), and the discrimination coefficients ranged between (0.41-0.91), based on what (Odeh, 2010) indicated for the acceptable extent of the difficulty of the item, which ranges between (0.20-0.80), as well as for discrimination of the item, the item is considered good if its discrimination coefficients is higher than (0.39), and it is acceptable and it is recommended to improve it if its discrimination coefficients ranges from (0.20 - 0.39), It is weak and recommended to be deleted it if its discrimination coefficients ranges between (0-0.19). The negative discrimination must be deleted. Therefore, none of the items were deleted based on the difficulty or the discrimination coefficients.

4.3 Students' Understanding of Fraction Problems Related to Group Variables

A t-test analysis was conducted to examine whether there are any statically significant differences in the means between the two groups. The results on the analysis are presented as shown below:

Pre-test

Pre fraction problem-solving test was administrated to both groups to know the actual level of students before starting the experiment, means, standard deviations and t-test were used to find out any significant differences between both groups of the study, as shown in table below.

Table 3: Means, Standard Deviation and T-test Results of the Experimental and Control Groups on the Pre Fraction Problem-Solving Test

	GROUP	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
PRE-TEST	Experimental	41	5.24	2.165	-.129	78	.898
	Control	39	5.31	2.261			

Table 3 reveals that students' scores for both groups were almost equivalent in pre-test before applying the experiment. This indicated that the two groups were equivalent, before starting the experiment. This also showed that the difference between scores of both groups on the Pre fraction problem-solving test was not statistically significant.

4.4 Analysis of Research Questions

Question 1: What is the effect of using Digital Games Based Learning on students' performance in fraction problem-solving?

For answering this question, means and standard deviations of the two groups for the method of teaching (Digital Games Based Learning vs. traditional instruction) were used and t-test were used to find out any significant differences between both groups of the study, as shown in table below.

Table 4: Means, Standard Deviation and T-test Results of the Experimental and Control Groups on the Post Fraction Problem-Solving Test

	GROUP	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
POST-TEST	Experimental	41	11.93	1.738	5.024	78	.000
	Control	39	9.90	1.875			

Table 4 shows the results for the comparison of performance between the means of both groups on the post fraction problem solving test. Specifically, there was 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, to investigate the level of impact of the treatment on experimental group, 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 Cohen (1988) 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 towards digital games-based learning between genders?

Table 5: Means, Standard Deviation and T-test Results of the Experimental and Control Groups on the Post Fraction Problem-Solving Test (Gender Variables)

	Gender	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
POST TEST	Male	21	5.33	1.770	.054	39	.957
	Female	20	5.30	2.179			

As shown in Table 5, the results for the comparison of performance between males and females 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).

4.5 Summary of the Results

This chapter focused on reporting the main findings of the study. At the beginning, the difficulty and the Discrimination Coefficient were considered appropriate. Second, the reliability coefficient was calculated by the method of internal consistency and it was found 0.95% where it showed that the test is reliable. Thirdly, statistical investigation was applied on both experimental and control groups showed that the samples are homogenous as the results of the pretest showed that the mean and the standard deviation of scores for both groups were insignificant. As observed the experimental group score (M= 5.24, SD=2.165) were almost equivalent to the control group score (M= 5.31, SD= 2.261) and the t-test showed (t= -.129).

Next, the results of student performance in the posttest were presented and observed, in the experimental group, teaching through the digital games was found effective in enhancing the learning outcomes compared to the control group, which followed the traditional teaching way. The posttest 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.

At the last the difference between genders in the performance toward the digital games-based learning were tested between the male and the female. 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) and this showed that there are no statistically significant differences at (α= 0.05) due to Gender variable. The results that showed the positive effect on the students' performance while using the digital games to practice could help in achieving the students requirements in grade five were the student should develop understanding of comparing and ordering fractions whose denominators are all multiples of the same number, add and subtract fractions with the same denominator and denominators that are multiples of the same number, recognize mixed numbers and improper fractions and convert from one to the other and write mathematical statements > 1 as a mixed number [for example, $\frac{2}{5} + \frac{4}{5} = \frac{6}{5} = 1\frac{1}{5}$] and prepare the students to be ready for level six to construct the new knowledge with the prior knowledge they have received in level.

Chapter 5: Discussion, Conclusions and Recommendations

5.1 Overview

The main purpose of this study was to determine if there is a significant difference in students' academic performance in solving fraction problems between the 5th grade students who used the digital games-based learning (ABACUS) and students who used the traditional way of learning in solving the same fraction problems and to show if there is a significant difference in the results between genders. This chapter discusses the findings of the study, its implications, and makes recommendations for better practice to reform Mathematics teaching-learning by using the digital games-based learning and the chapter concludes with suggestions for further research on the integration of mathematics digital games into the teaching and learning process in Mathematics.

5.2 Discussion of the Results

5.2.1 Student Overall Mean Total Scores on the Pre and Post test

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 two groups were equivalent, before starting the experiment and this showed that both groups were homogenous in terms of understanding of the test objects.

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).

Figure 7: Students' Overall Mean Total Score in the Pre- and Post-Test

Thus, it can be clearly explicated that the performance of the students of grade 5 in solving fraction problems using the digital games in the selected school in Al Ain has been enhanced due to the adoption of ABACUS active learn.

It can be drawn from these results that ABACUS had a positive impact on the students' performance in learning fraction as shown in Figure 7. The possible reason for this finding could be that ABACUS enabled students in the experimental group to practice and solve fraction problem through digital games is the motivation. 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 happiness and enjoyment while playing the games could be a factor that affects the performance of the students on 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, students in the experimental group had the opportunity to practice more fraction problems with three different levels for each game by having the reward system, where the students are getting points whenever the solve a question, they increase their points and therefore they could get and collect rewards from the ABACAS site, while the control group could not do the same. This will challenge the students in the experimental group to solve more questions to increase their point and at the same time moving to the harder level to get more point and this would help them to confirm the conceptual fraction lesson taught at the class and practiced by the games.

ABACUS gave the chance to the students to learn by themselves through the digital games and explore more on the ABACUS active learn through the digital resources available to the students to learn more about a specific mathematics fraction topic. The features of using ABACUS lays on the rewards available to the students and the point they could get whenever they solve more question, the challenges they could face while solving the question, keeping in mind that when they solve more they

could get more points and more rewards could make them excited to go through the three levels available in the game and this will result improvement in the performance and encouraging in solving more question Similarly, Kim and Ke (2017) showed that there is a positive effect including the DGBL in accordance with math learning, the results finalized that the digital games includes the characteristics challenges, rewards and integration of game play with learning content 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, by the teacher's explanation only with 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, where this affected the teaching and learning process negatively. The students felt bored after solving few questions in the class and waited for the teacher to check.

5.2.2 Student Overall Mean Total Scores of the Experimental Group between Gender

The difference between genders in the performance toward the digital games-based learning were tested between the male and the female. 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), and this showed that there are no statistically significant differences at (α= 0.05) due to Gender variable.

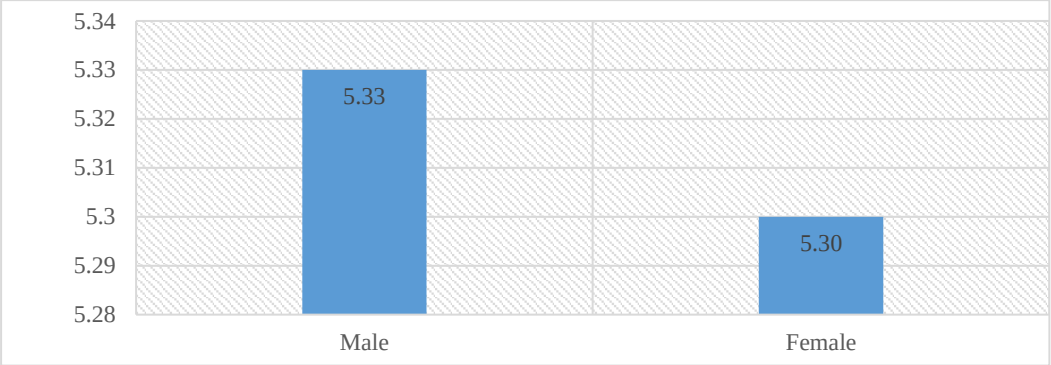

Figure 8: Students' Overall Mean Total Score in the Post Test between Gender

The results in Figure 8 showed that no matter the gender is, the resources and the strategies in teaching Mathematics fractions is the way that affected the performance of all genders of grade 5. 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. Unlike Lowrie and Jorgensen (2011), who had another result 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, point 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 and therefore the performance would be better for both groups. which benefits the learners by helping them enhance their learning process and cognitive understanding regardless the genders.

5.3 Discussion of the Results in Relation to the Literature

Technology in the classroom and at home is an important element to be used and integrated in the teaching and learning process. In this section the researcher will discuss the impact of the ABACUS digital games-based learning on students and its possible outcome in relation to Mathematics teachers and the mathematical knowledge, the digital resources available on ABACUS with the detailed lesson plans, the differentiated activities and the digital games related to the fraction concept taught where the teacher could assign the game to be practiced by the students using the electronic devices in the class or at home had a positive effect in delivering the lesson to the students and therefore their performance got better. This study showed that the use of the digital games in ABACUS effected the performance of the students positively and it concluded that the factors affected the student's performance are: Enjoyment and happiness, challenges, motivation, points and rewards through the digital games in ABACUS result in better performance in Mathematics.

Enjoyment and happiness

High level of curiosity and engagement to receive more games to solve on the fraction topic. This was observed by the researcher when students contacted the Mathematics teachers to assign 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 determine the knowledge acquired by the learner.

The enjoyment and the happiness are two important factors which shows that the learners are solving more questions by playing more games with different levels. Allocating games through ABACUS active learn to the students gave the teacher an

opportunity to check if the students are enjoying and happily solving different levels and from this feature on ABACUS the teachers can 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) that the enjoyment of playing a game can help in improving the performance of the learners. As stated in previous research that digital games promote the learning of mathematics problem-solving and showed that the digital games had a positive effect on the student's achievements as mentioned by Dayo, Alvi and Asad (2020).

Challenges

In addition, students' Enjoyment and happiness while playing the games in ABACUS the challenges to solve more fraction problems in ABACUS increased as seen by the researcher when this study was managed, students were excited to practice more fraction problems by finishing the three differentiated levels in each fraction game to gain more points and therefore more rewards. Using ABACUS active learn provided the students with different levels to solve fraction problem starting with the bronze level, the silver level then the gold level where you can see the questions are getting more harder on the next level and the points are getting more higher where this enhanced in the learning process. This was obvious for the Mathematics teachers when they observed that the students are excited and solved the assigned games with all the levels (bronze, silver and gold) as mentioned in Figure 9.

Figure 9: Game Three Levels

The challenges the students faced in solving the question encouraged the students to use different way to solve the questions, students started to search for the ways to answer the questions they were stuck by asking their friends and sharing their opinion to try to solve the question , even they stated using the internet to search for ways to solve the questions to get more points and this helped the students to learn by doing by using the knowledge they have in mind and constructing new knowledge in the new concepts learnt. As mentioned by (Anwar and Rahmawati, 2017) “The Math learning which is based on constructivist theory provides the knowledge that is not only stored in the minds of students, but it should be constructed by the students through active involvement in learning process”.

Motivation

Students nowadays are facing many problems in learning fractions in Mathematics. The students received the way of solving the fraction problems without having a suitable change to let them study or practice by themselves to build their own understanding and experience. When students used the ABACUS active learn, they were more engaged in their own learning and more confident of their ability in solving more mathematical fraction problems. As agreed by Huang and Huang (2015), that the digital games significantly improved the low-achieving students' motivation and performance in the learning process. The motivation they gain through solving more games with different levels, encouraged them to play more games to collect more points.

Points and rewards

ABACUS active learn site provided with point to be added to the students account as shown in Figure 10, whenever the student solves a question and move to another question and when the students finish the first level and move to the second the change to get more points will increase with the next level. Collecting more points has given the students the chance to buy and collect rewards from the rewards system available on ABACUS as shown in Figure 11.

The reward system combined to the digital games encourages the students to solve more difficult challenging questions, the challenges have supported the students to keep focused in their paly and eventually supported the learning process as mentioned by Kim and Ke (2017) and this idea is supported to previous research stated that the reward is one of the most important elements in game structure to stimulate more active learning and to help players sustain in game-play (Moon, Jahng and Kim,

2011) and this supports the rewarding system available on ABACUS active learn. The rewards encouraged the students to play more to get more points and get rewarded.

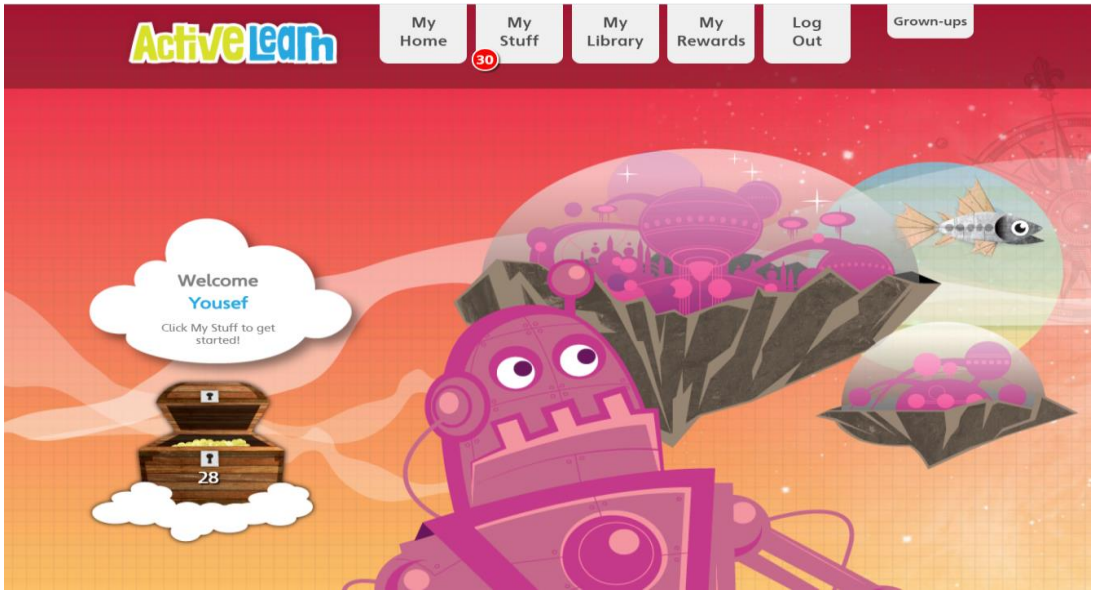

Figure 10: Student's Account

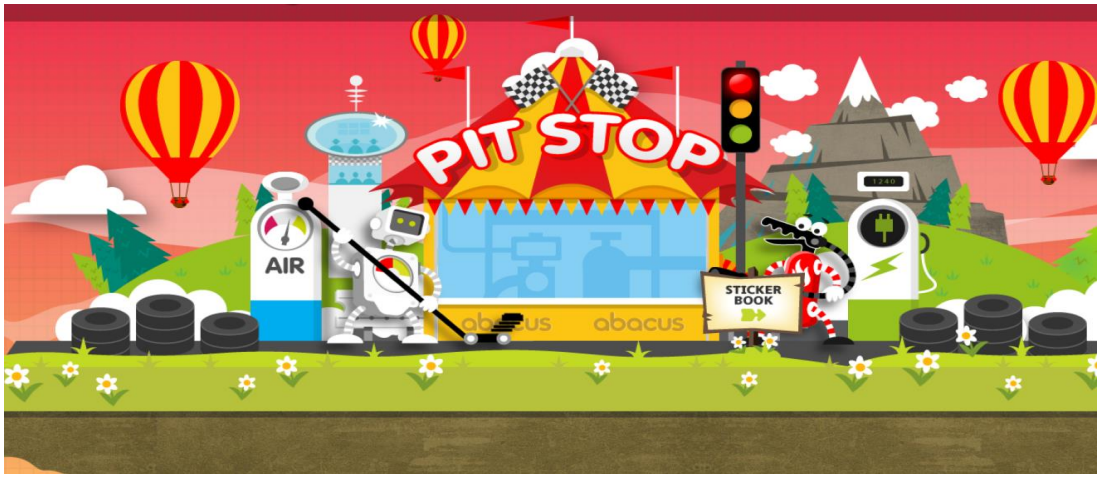

Figure 11: Reward System

As for teachers, Technology is a challenge to be used and many teachers are still not familiar with the proper use in the teaching ways. ABACUS active learning provides the teachers with the completed lesson plan with the integration of the technology tool that suits each Mathematics lesson and the way of using the tools to deliver the lesson through the integration of the technology. Some teachers are avoiding the use of technology in their teaching. Training teachers is an effective way to ensure that they are capable to use the features ABACUS provides for teaching Mathematics through the digital tools available in each lesson as Demirbilek and tamer (2010) suggested that the professional development training regarding to introduce the educational computer games is crucial to change the Mathematics teachers attitude toward computer games. ABACUS active learn is an easy website to be used by the teachers who have the minimum level of computer skills. In the schools the students and teachers have access to the internet and can use their laptops and I pads in learning and teaching process, which makes it easier to the researcher to conduct the study.

The main disadvantage of the use of the technology is that some students are using the I pads and the laptop to play games not related to the lesson even at school while studying at home, the teachers and the parents should keep track of the students with studying and practicing Mathematics on ABACUS account. The support purpose of ABACUS in the teacher's instruction is not negotiable; it saved time for teachers to move forward with their material. It also could give teachers a chance to move forward with their curriculum and use this time in other topics in Mathematics that needs more time and effort from both students and teachers. In summary, teachers should be

grateful for these digital games learning for its efficient support for leading to a better and fruitful learning environment.

Moving to the most important domain, mathematical knowledge is the main focus of this study as the research has examined the impact of the digital games-based learning ABACUS active learn on the student's performance. In fact, the results of the students showed the positive impact of ABACUS on their learning the fraction concept and when learning new mathematical concepts. The feature of the ABACUS website that it gives the students more practice in a challenging way for each mathematical topic with the technology tools available for each lesson 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.

5.4 Recommendation and Suggestions for Further Research

As proved in many studies, the including of the digital games through the Mathematics lessons were productive for all elements of the learning and teaching process. Literature review showed that the implementation of the digital games through teaching fraction had a positive effect on the student's performance in solving fraction problems, including that the digital games encourage the students to play more and solve more problems.

The study concluded that teaching Mathematics through the digital resources and including the digital games affected the students' performance in solving mathematical fraction problem and increase the motivation of the students to solve more and acquiring more knowledge and ways in solving fraction problems.

In light of the previous results, the following recommendation and suggestions may be considered:

Teachers are advised to use the ABACUS active learn in their Mathematics classes. Mathematics teachers have been insisted to use the technology and the digital tools from ABACUS active learn where it contains a lot of tools that help the teachers to deliver the mathematical lesson in an active way. Providing the students with the opportunity to study and work independently is an important goal on the learning process and ABACUS gave the chance to the students to work and practice more independently. On the other hand, it gave the teachers more time to finish the curriculum, ensure that the objectives are achieved, and the students got their chance to work more on the way of games to practice more at home or even on the classroom using the digital devices laptops or I pads.

Many schools are equipped with the technology on class and the digital resources with the digital tools available to reinforce the teaching and learning process, Teachers are not capable with the technology use and many teachers refuse the use of the digital tools to explain and found it hard to deal with the technology with the students. The researcher recommends training the new teachers and teach them how to integrate the technology during the lesson and how to benefit from the tools ABACUS provide to make their ways of teaching mathematical concepts easier and smoother. During this period with the circumstances the students are facing a big change with the total online teaching and using the technology at all times and applying the active learn either from home or from the school. The researcher found that the students can learn and practice mathematical problems using the digital games and the researcher found it beneficial to let the student study using the digital games, so they change the way of sitting in front of the device listening to the teacher. The researcher found that the students were

more excited to play games to solve the mathematical problems than only listening to the teacher explaining and talking and then solving worksheets. Students were motivated to play mathematics games than just studying through the traditional way.

ABACUS encourages the students to keep in touch and ask each other about different mathematical problems and the way of solving to get more points and to move to the next level and this way encouraged them to study and learn independently.

It is recommended also 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.

5.5 Limitation of the Study

After applying the Quasi-experiment research to show the effect of digital games-based learning on grade 5 performance, the researcher found some limitation that could affect the results of the study, here are the limitations of the study:

1: The length of the intervention for three weeks and this might be considered as a limitation, if the study intervention continued for the whole term, this might have influenced the results of the study.

2: The study did not look at the student's perception and attitude digital games-based learning.

3: The study was applied on 4 classes of grade 5 with total number 80 students, this might also be considered as a limitation, if the study included more sections of grade 5, this might have influenced the results of the study.

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Appendix

Appendix -Pre and Post test

The test below is the one used as pretest and posttest:

$\frac{10}{5} - \frac{2}{5} = \square$

$\frac{5}{6} - \frac{2}{3} = \square$

$\frac{1}{2} + \frac{1}{8} = \square$

$\frac{1}{4} + \frac{2}{4} = \square$

$1\frac{1}{5} - \frac{3}{5} = \square$

$\frac{6}{5} - \frac{3}{5} = \square$

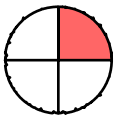
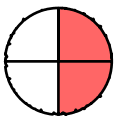
$1\frac{1}{4} + \frac{5}{4} = \square$

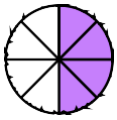
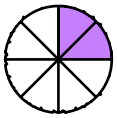
$\square$

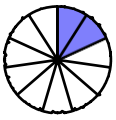
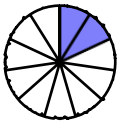
$$\frac{5}{4} + \frac{5}{4} =$$

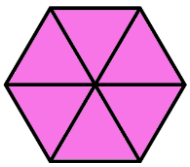
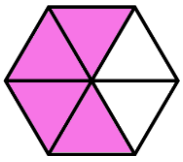
$$\frac{2}{4} + \frac{3}{2} = \square$$

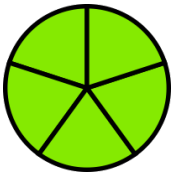
$$\frac{5}{3} - \frac{4}{9} = \square$$

1)  +  = ☐

2)  -  = ☐

3)  +  = ☐

4)  +  = ☐

5)  -  = ☐

Appendix- To Whom It May concern

UAEU كلية التربية College of Education

جامعة الإمارات العربية المتحدة United Arab Emirates University

Date: 28-03-2021

To Whom It May Concern

This is to confirm that **Haneen Almassri (ID: 201870081)** currently a Master student at the College of Education- Major **Curriculums & Instructions in Mathematic** , at United Arab Emirates University .She is conducting a study for her final course on:

The Impact of Digital Games Based Learning (ABACUS) on students' performance in fraction for fifth Grade students in Al-Ain

We kindly ask for permission to allow **Haneen** to start her questionnaire at your school.

Respectfully,

Ali Shehadeh

Prof. Ali Shehadeh

Master Coordinator

Appendix - Letter of Cooperation for Data Collection in Schools

Dear _____,

I, ……..as a graduate student in the Curriculum & Instruction Department at United Arab Emirates University, I am conducting research as part of the requirements for a Master Degree in Education. Under the supervision of Dr. Adeeb Jarrah. The Purpose of this letter to ask for permission to conduct the study. The title of my research project is:

"The Impact of Digital Games Based Learning (ABACUS) on students' performance in fraction for fifth Grade students in Al-Ain."

ABACUS active learn is an inclusive online site for teachers and students to illustrate and learn mathematics in primary level. ABACUS is considered as an online innovation that enable the students to have the ownership of their learning through interactive activities that can be done independently in the classroom or spend their rewards in online learning games. The main objective of this study is to examine the effect of using ABACUS on students' performance of 5th grade while studying Fractions. This study designed to be tested in Al-Ain, United Arab Emirates. I am writing to request your permission to conduct my research in _____in Four Mathematics classrooms. The study will take approximately three weeks. Data will be collected at the beginning and the end of the study and will involve a student pretest and a student posttest. Participate in this study will be grade 5 students, two classes in the control group (normal teaching methods occur) and another two classes will be in experimental group ABACUS instruction. The data collected will be used to investigate the impact of ABACUS on students' performance when they are learning fractions. Participants will be presented with informed consent information prior to participating. Taking part in this study the confidentiality and privacy of the research result, the use of data will be for research and for supporting the students with the best teaching methods to improve their fraction performances.

On behalf of _____ , I _____
have no objection for conducting this study in _____

Name:

Signature:

Appendix-CONSENT FORM FOR PARTICIPANT'S PARENTS

TITLE OF THE STUDY: The Impact of Digital Games Based Learning (ABACUS) on students' performance in fraction for fifth Grade students in Al-Ain

Researcher: Haneen Almassri

I have been given information about the research project entitled "The Impact of Digital Games Based Learning (ABACUS) on students' performance in fraction for fifth Grade students in Al-Ain" and the researcher project with Haneen Almassri who is conducting this research as part of Masters requirements supervised by Dr. Adeeb Jarrah from UAE university.

I have been advised of the risks and benefits associated with this research and have had an opportunity to ask Haneen Almassri any questions I may have about the study and my son/daughter participation in this experimental study.

I understand that the results of this study will provide inputs for this research, which aims to investigate the effect of digital games-based learning on grade five student's performance in mathematics. Findings of this study will be available for you to explore after thesis submitted and published in the UAE University.

I also understand that the collected data will be used for publication such as master's thesis and journal articles.

By ticking the box below, I give my consent to let my son/daughter participate in the Experimental study of this research.

☐ Participating in the Experimental Study

Signed: ..……. Date: ……/……/……

Parents Name:
……

Appendix-Sample of the ABACUS lesson plan

Plan: Abacus Year 5 **Week:** Week 19 Teacher**:** Haneen AlMassri **Date:** 29/03/2021

Year 5 Lesson 93

Strand: FRP Fractions, ratio and proportion; **PRA** Problem solving, reasoning and algebra

Main Focus: Write improper fractions as mixed numbers and vice versa, look for patterns and write rules

Objectives: FRP.64 Convert mixed numbers to improper fractions and vice versa; **PRA.70** Identify patterns, devise and test rules and use them to make predictions

Prior Learning: Read and understand mixed numbers and know how many of a given fraction make a whole one

Key Vocabulary: fraction; mixed number; equivalent; improper fraction; numerator; denominator

Outcomes: Children can: write improper fractions as mixed numbers and vice versa; look for patterns and begin to write rules.

Starter:

ST 5.19.3 24 hour time

Put chn in pairs. Show a time on an analogue clock or use Clock tool 5.19.3 saying that this is a time after 12 noon. One child writes the time as it as would appear on a 12-hour digital clock writing pm afterwards, and the other writes the time as it would appear on a 24-hour digital clock. *What might you be doing at that time?* Rpt, chn swap roles each time.

Main Teaching:

Teaching

- Show chn a collection of fractions on Screen 5.19.3a, some of which are proper fractions and some of which are improper fractions: 5/6, 15/5, 7/10, 7/12, 11/4, 20/7, 7/5, 3/8, 19/3. Read each fraction together.
- Discuss how we could sort these into two sets. First, fractions whose numerators are smaller than their denominators, e.g. 5/6. Explain that these are called proper fractions, point to the heading on the table on screen. Then fractions whose numerators are greater than the denominators, e.g. 13/5, reminding chn that these are called improper fractions.
- Remind chn how to write improper fractions as mixed numbers by counting up the number of whole pizzas there are in all the slices. *How many whole pizzas are there if I have thirteen-fifths? One whole is five-fifths, two wholes are ten-fifths, so we have two wholes and three-fifths left over*. Write *13/5 = 2 3/5*.

Short task

Chn work in pairs to sort the fractions into two sets, and to write all the improper fractions (numbers of slices) as mixed numbers (whole pizzas and some slices).

Teaching

- Take feedback and together drag and drop the fractions into two sets, choosing chn to come and write the equivalent mixed numbers next to each improper fraction.
- Show an addition: 3 + 2/5. Ask chn to suggest the total. Draw out that it is an easy sum — we do not have to do any work! The total is 3 2/5.
- Ask chn to write quickly on whiteboards the number of slices in all as an improper fraction (remind them that these are fifths).
- On a 'one, two, three, show me!' look at chn's whiteboards. *Have we all written seventeen-fifths?* Emphasise that the slices MUST be fifths as the denominator is 5 in the fraction part of the mixed number (3 2/5). *There are five slices (fifths) in each whole pizza, that is fifteen, plus the two extra slices. We write this as an improper fraction, seventeen-fifths.*

Short task

Chn work in pairs. They each write a mixed number, i.e. a number of whole pizzas and a fraction, e.g. 3 1/4 and swap whiteboards. Their partner writes the number of slices as an improper fraction, e.g. 13/4.

Teaching

- Look at the chn's pairs of numbers. Are they all equivalent? Look for any mistakes and decide what we can learn from these to stop us making the same mistake twice! *These are good mistakes because we learn from them.*
- Emphasise that in an improper fraction the numerator tells us the total number of slices and the denominator tells us how many pieces each whole has been cut into, e.g. 13/4 is 13 slices, and each slice is a quarter. A mixed number tells us the number of whole pizzas and the extra slices, e.g. 3 1/4.

Mastery Checkpoint

Use Mastery Checkpoint 5.19.23 (Teacher Guide 5.19.23)to assess mastery of the following outcomes. You can use it in this lesson or at another time in the day that suits you.

- Recognise mixed numbers and improper fractions and convert from one form to the other; look for patterns and write rules
- Place fractions on a number line and count in steps of a given fraction, using equivalence

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Core:

(T) PSR.C 5.19.3 Investigating with mixed numbers and improper fractions

Show chn Screen 5.19.3b. They work in pairs to write a mixed number of pizzas where the whole number is 1. They then write the mixed number as an

improper fraction. They compare numerators. *Are they both odd, both even or one of each? Is the denominator odd or even?* Keeping the number of whole pizzas as 1, chn explore even and odd patterns in the numerators and denominators. Remind them to write the fraction part of a mixed number in its simplest form. Ask: *What happens if the denominator and numerator are even?* (You can simplify the fraction.) *Can both the numerator and denominator be odd? When does this occur? If the denominator is odd, can you get an even numerator in the improper fraction? When does this occur?* Encourage chn to write rules to explain the patterns. Ask chn to try with 2 as the whole number, e.g. 2 3/4. *Is the pattern still the same?* Support chn in making and testing rules.

Assessment focus

- Can chn change mixed numbers to improper fractions?
- Can chn spot patterns, make and test predictions, and begin to write rules?

Support:

(T) PSR.S 5.19.3 Mixed numbers and improper fractions investigation

Using the fraction number lines on RS 549 Landmarked lines 0-4 (thirds, quarters, tenths, fifths, eighths) chn label each line with the relevant fractions. Starting with the second number line they choose two marker points between 1 and 2, writing each as a mixed number and as an improper fraction. They count on from 1 1/4, e.g. 1 1/4, 1 1/2, 1 3/4, in mixed numbers and in improper fractions: five-quarters, six-quarters, seven-quarters, etc. Chn rpt for the other lines. Working in pairs one child compares the 1/3 and 1/5 numbers: Is the denominator odd or even? In each pair are the numerators odd or even or a mix of both? When the numerator is odd in the mixed number, it is even in the improper fraction and vice versa. The other child compares the 1/4, 1/8 and 1/10 numbers, asking the same questions. They will find either both will be odd or both will be even. Encourage them to write a few rules to explain the

patterns they find. They should make up some more fractions between 1 and 2 to check their theory. Support chn in making and testing rules.

Assessment focus

- Can chn change mixed numbers to improper fractions?
- Can chn spot patterns, make and test predictions, and begin to write rules?

Extend:

(T) PSR.E 5.19.3 Investigating with mixed numbers and improper fractions

Show chn the instructions on Screen 5.19.3b. They work in pairs to write a mixed number of pizzas where the whole number is 1. They then write the mixed number as an improper fraction. They compare numerators. Are they both odd, both even or one of each? Is the denominator odd or even? Keeping the number of whole pizzas as 1, chn explore even and odd patterns in the numerators and denominators. Remind them to write the fraction part of a mixed number in its simplest form. Ask questions such as What happens if the denominator and numerator are even? (You can simplify the fraction.) Can both the numerator and denominator be odd? If the denominator is odd, can you get an even numerator in the improper fraction? When does this occur?

Encourage chn to write rules to explain the patterns they find and to test their rules with other mixed numbers. When chn are ready, ask them to explore numbers between 2 and 3. Is the pattern still the same or different? What would happen to the patterns for numbers between three and four? …four and five? Can you write a general statement to explain what will happen for any whole number part?

Assessment focus

- Can chn change mixed numbers to improper fractions?
- Can chn spot patterns, make and test predictions, and begin to write rules?

Further Support:

Give chn fraction lines RS 548 Landmarked lines 0-3 (halves, thirds, quarters, fifths, sixths, sevenths, eighths, ninths, tenths) or Fraction and decimal number line tool

5.19.3 showing a 0-3 number line marked in quarters. Chn count how many quarters are equivalent to 1 1/4, for example, to convert 1 1/4 into an improper fraction. Use the arrow to slide up the number line.

Depth and Extension:

N/A

Plenary:

Ask different pairs to feedback what they found in the investigation and share their rules. Do other chn agree?

Physical Resources

- an analogue clock
- whiteboards

Photocopiables

- RS 548 Landmarked lines 0-3 (halves, thirds, quarters, fifths, sixths, sevenths, eighths, ninths, tenths)
- RS 549 Landmarked lines 0-4 (thirds, quarters, tenths, fifths, eighths)

Digital Resources

- Clock tool 5.19.3
- Fraction and decimal number line tool 5.19.3
- Lesson: Year 5
- Mastery Checkpoint 5.19.23
- Screen 5.19.3a
- Screen 5.19.3b

Suggested Homework

Individual Practice Games

- Cave Commotion 5.19a
- Cave Commotion 5.19b
- Cave Commotion 5.19c