ATTRACTING KIDS IN LEARNING BASIC MATHEMATICS THROUGH GAMIFICATION

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled **"Attracting Kids in Learning Basic Mathematics through Gamification"**, submitted by Esmat Ara Eva, ID No: 151-15-4796 and Rasheduzzaman Rion, ID No: 151-15-5228 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on the 11th December, 2018.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Dr. Sheak Rashed Haider Noori, Associate Professor and Associate Head, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

The objective of the study is to encourage children for initiating their computation practice and drive them towards mathematics using M-learning (Mobile learning). For this purpose, a prototype of android mobile application containing the elementary arithmetic operations DMAS (Division, Multiplication, Addition & Subtraction) illustrated by animations is built up. Children tend to love animated series and can catch the storyline in the blink of an eye no matter in which language the episodes are made up of, even if it's of an unfamiliar language. Same theory is applicable for mobile games too. A child finds out about the rules of a game all by itself because the game is able to attract the child successfully. Kids learn new things really fast and much faster when it's something of their interests. Our aim is to utilize this interest in order to trigger their engagement, involvement and motivation.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Kids of this generation are becoming so much addicted to virtual games because of not having the facility of playing outdoor games as well as the unavailability of playmates required for playing other types of indoor games and nowadays most of the kids have access to the cellular phones. The motto of this application is to use their addiction in a good way by providing some lessons through games.

This application is intended to make kids of play level introduced with very basic operations of mathematics while playing and enjoying the learning process. They can learn addition, subtraction, multiplication and division – only these four rules for beginners to initiate their journey of mathematics in a very easy and interesting way so that they don't find mathematics hard at the very beginning.

It doesn't want to promote any kind of competition but they can solve problems just to make sure if they are learning properly or not. So exercises are given to take tests but no scoreboard or ranking system or is added in this app but they can see the number of correct or wrong answers to observe their progress.

1.2 Motivation

Nowadays kids have a lot of pressure of study on their delicate shoulder. They don't get the proper time for recreation. Putting too much pressure on them can backfire severely and end up affecting negatively in a number of different ways.

When children are taught a method of mathematics with only numbers, they can't catch that easily. Even if they understand, they can't remember that for a long time without a regular basis of practice. But if they are provided examples with real life things, such as chocolates or fruits, they learn the same method very quickly and remember for a longer period of time.

Some kids find it very tough and a fear of mathematics grows inside them. As a result, they only tend to memorize the solutions without understanding the problems properly only to get marks in examination and can't sense its usefulness in real life.

1.3 Rationale of the Study

To sail a pleasant long voyage of acquiring vast knowledge lying ahead, the basement of lesson needs to be strong. Moreover, mathematics of primary level is something that is a must for our everyday life and all kinds of people regardless of their age need it in every sector at each step of the life. Children will be able to relate the mathematics with their applications in daily life easily if they are taught those problems by using real life examples.

The proceeding of learning will be easier if fun is added with it and at the same time it will save a lot of time presenting a better learning experience as well as environment. On the other hand, instant feedback is received throughout the procedure and this kind of learning process helps people to remember things for a very longer period of time also.

1.4 Research Questions

To reach the goal of our study, is as far as we can from the available resources, we intend to answer these two research questions:

- How can gamification be applied in the field of education?
- Can it assist little children in learning mathematics?

1.5 Expected Outcome

A second thought on our traditional teaching system should be given which is putting so much pressure of study upon the children of this generation. As a result they are losing their playtime, smile, innocence etc. in one word childhood. Emphasis should be given in discovering the effective ways of tutoring for kids to ease their educational journey.

A consideration on the monotonous way of schooling should be given and more educational games should be introduced so that education, which is a mandatory, doesn't become unendurable burden but a beautiful experience. Education shouldn't be the bitter medicine which is taken forcibly against our will but the nectar which is sought desperately.

CHAPTER 2

BACKGROUND

2.1 Introduction

Gamification is applying a playful design on a system and making the system fascinating enough to increase the people's involvement without using any extrinsic force. The thought behind this came from the concept of games after visualizing how games can keep people adhere to it for hours by using only one policy and that is fun. The term 'Gamification' is very much newer and it was introduced first by Nick Pelling back in 2002 as part of his consultancy business, Conundra Ltd. But it was defined and explained first by Terill in 2008. Thereafter this concept got recognition. However, it was started to be given considerations and be adopted around 2010. Now it is being applied in various fields, such as: industry, army, marketing, business, research, education etc. It is mainly popular for being used in the education system widely to trigger students' engagement.

2.2 Related Works

Q2L (Quest to Learn) is a fully gamified public 6-12 school which is situated at New York. In that school students are taught with an innovative educational philosophy i.e. serious educational games instead of books. Their average student attendance rate is 94%. Performance of the students of the school is also extraordinary.

Code school presents Rails for Zombies built by Gregg Pollack is a game for learning Ruby. Ruby is a very high level programming language that is very useful but easy to learn. It is a simple but dynamic object-oriented language that has automatic memory management.

Shannon Butler and Dewan Tanvir Ahmed [1] conducted a research to motivate students of computer science background in programming by applying gamification. They used a game engine named Unity3D and #C programming language to make an interesting game of two levels. They taught few students two algorithms through game playing, took an instant test afterwards and got a satisfying result.

Hiroaki Furukawa, Takaya Yuizono and Akira Sakai [2] performed an experiment on gamification by making a creativity supporting tool. They created a brainstorming game in which people can gain points for generating new ideas and can create an avatar using those earned points and can also compete other players.

Maria-Blanca Ibanez, Member, IEEE, Angela Di-Serio, and Carlos Delgado-Kloos, Senior Member, IEEE [3] did a case study to investigate the impact of gamification on undergraduate engineering students to learn basic concepts of C-programming language. They designed a gamified learning platform named Q-Learning-G where students' academic goal was to earn 100 grade points by performing three kinds of activities - work, planning and social.

C-H. Su and C-H. Cheng [4] developed and implemented an MGLS (Mobile Gamification Learning System) in an elementary school science curriculum to help the students in their botany course by outdoor learning activities. Students could find their learning objects in a nearby natural environment by the help of GPS + Google maps configured in the application and using a 2D QR-Code scanner, they could perceive about the object in details.

2.3 Scope of the Problem

A child's mind is very much unpredictable. Sometimes they can be lured by very silly things which is totally unexpected and out of imagination. Sometimes even fancy things can not attract them or keep them engaged for a longer time. Their minds can change anytime without giving any advance notification. Thus it's going to be a very difficult task to draw their attention, most importantly keep them involved for enough time. If they don't find it quite appealing at the first glance, they won't give any further effort to understand the mathematics. Another possibility is situation like this can appear that they will like it at the beginning but in the middle they can lose their appetite and leave it incomplete.

2.4 Challenges

The target audience of the application is children of very young age which was the biggest challenge of this research. We tried to think like them at their level to make a

playful system for them. We always had to keep it in mind that whether the overall structure specially the method will be understood by them easily or they will face any difficulty. We thought of so many methods but at the end, rejected most of them because of this limitation. Finally we adopted and implemented an idea which we found the best.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Data Collection Procedure

The following steps have been taken to make the required prototype and collect necessary data:

- A study on gamification has been done to get a clear idea about this topic before exercising.
- A generous amount of background study has been done to perceive how it has been applied in the field of education so far.
- A few research papers have been read regarding this area.
- Discussions with some children have been directed individually to know about their preferences.
- A draft UI (User Interface) design of the application has been made on a paper.
- A use case diagram has been drawn to organize application requirements.
- An experiment has been conducted on 10 elementary school going students individually whose ages vary from 7 to 9 years old. The participants were picked in such a way that the selected children were acquainted with the natural numbers very well but had a little or almost no idea about how to perform the primary arithmetic operations.
- At first, they were given some help to initiate the learning session.
- After giving enough time to watch the tutorials, they were given some multiple choice questions to solve.
- All necessary details have been noted.

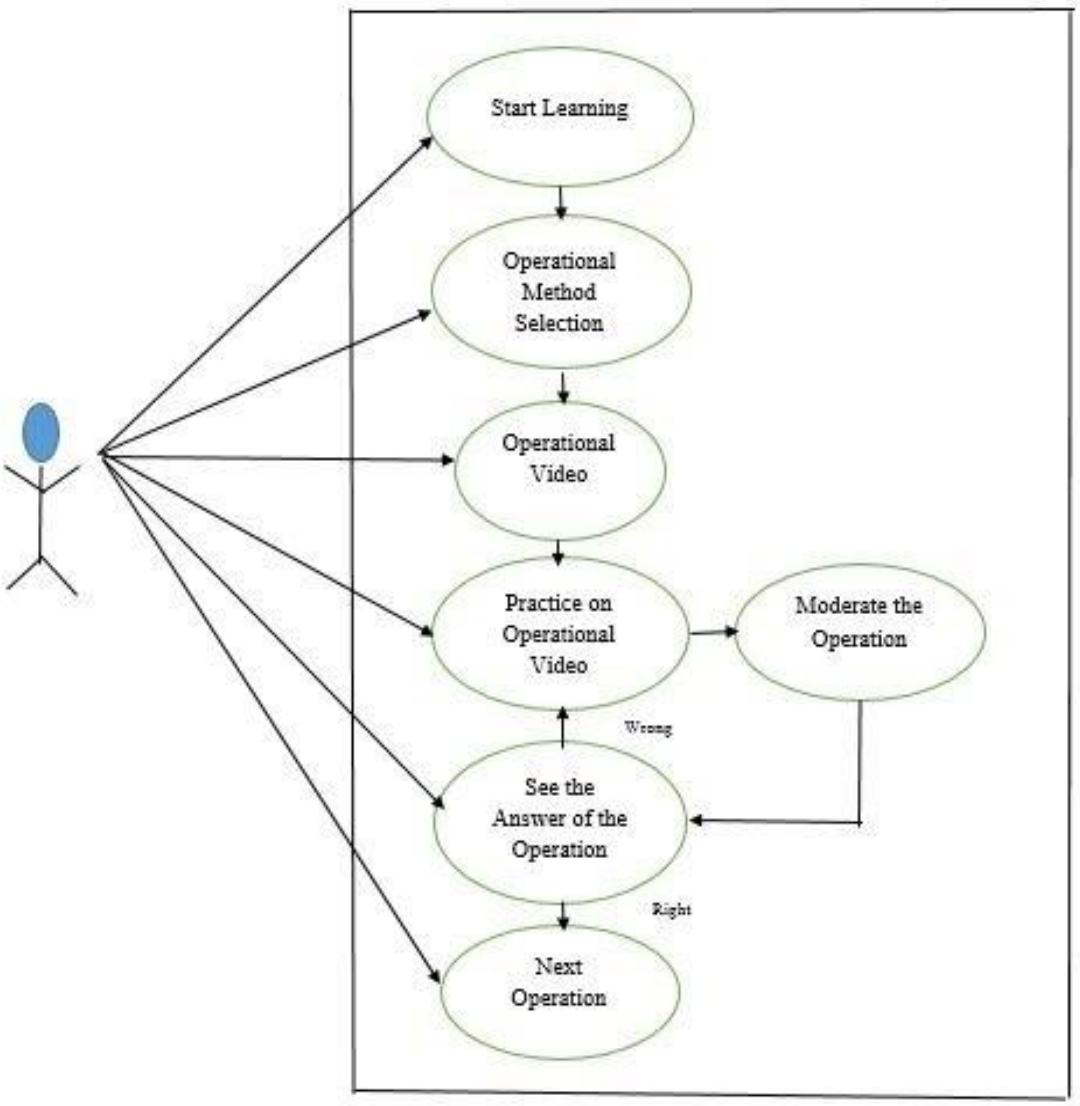

Figure 3.1: Use case diagram of the application

Use Case Description:

- The actor loads the application and then starts the process of learning.
- The actor selects the intended operation to begin the learning process.
- The actor watches the essential animation video and can also rewind the video if wants.
- The actor can practice some related problems.
- After starting practice session if the given answer is incorrect, further questions cannot be accessed till the actor chooses the right option. But the learning session can be restarted and continued.

- If the given answer is correct, more questions appear one after another if the actor presses the ‘next’ button.

3.2 Implementation Requirements

Android smart phones have been chosen as our target devices because it is the most available and suitable electronic option among all for almost every child. Android studio has been used as the MADP (Mobile Application Development Platform). API (Application Program Interface) level has been set from 19 to 26 (Android 4.4 - 8.0) which avails any android wear of the OS (Operating System) version KitKat to Oreo. It is an offline application, which means the users don’t need a connection to the Internet to run it.

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Implementation Results

After the implementation of all functions and features, the application was installed and so run on an android cellular phone. It works perfectly as a prototype. The details are briefed below:

i. At first, a welcome activity takes place. A button appears in this activity. If the button is pressed, it goes to the next activity. An animation has been used here which shows a moving wheel surrounding the button when we press it.

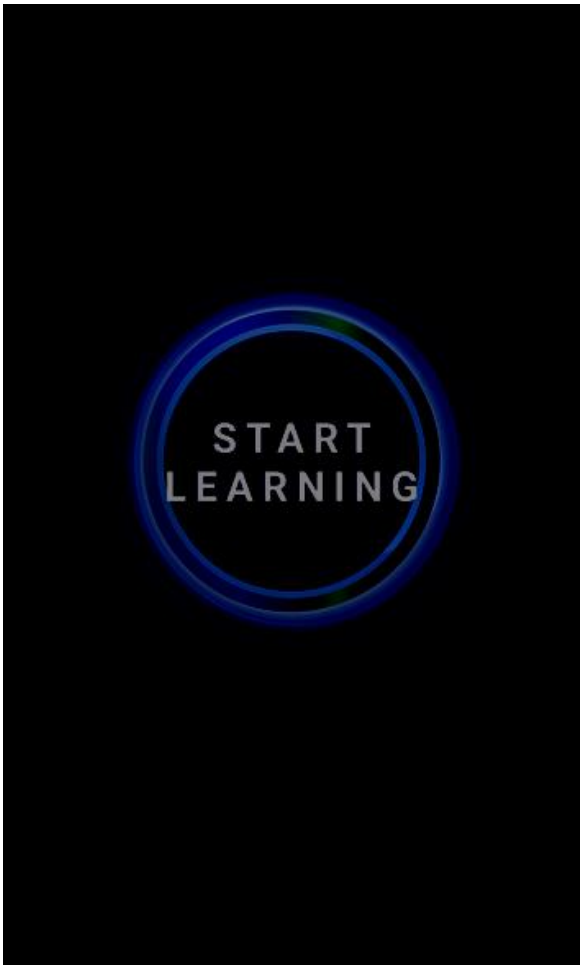

Figure 4.1.1: Starting window

ii. After pressing the start button, it goes to the next activity. Here, we have used four fragments for four buttons (Addition, Subtraction, Multiplication and Division). Another button is present below for practice.

When an operator sign is pressed, it shows a tutorial for the respective rule. This is a GIF image view for learning.

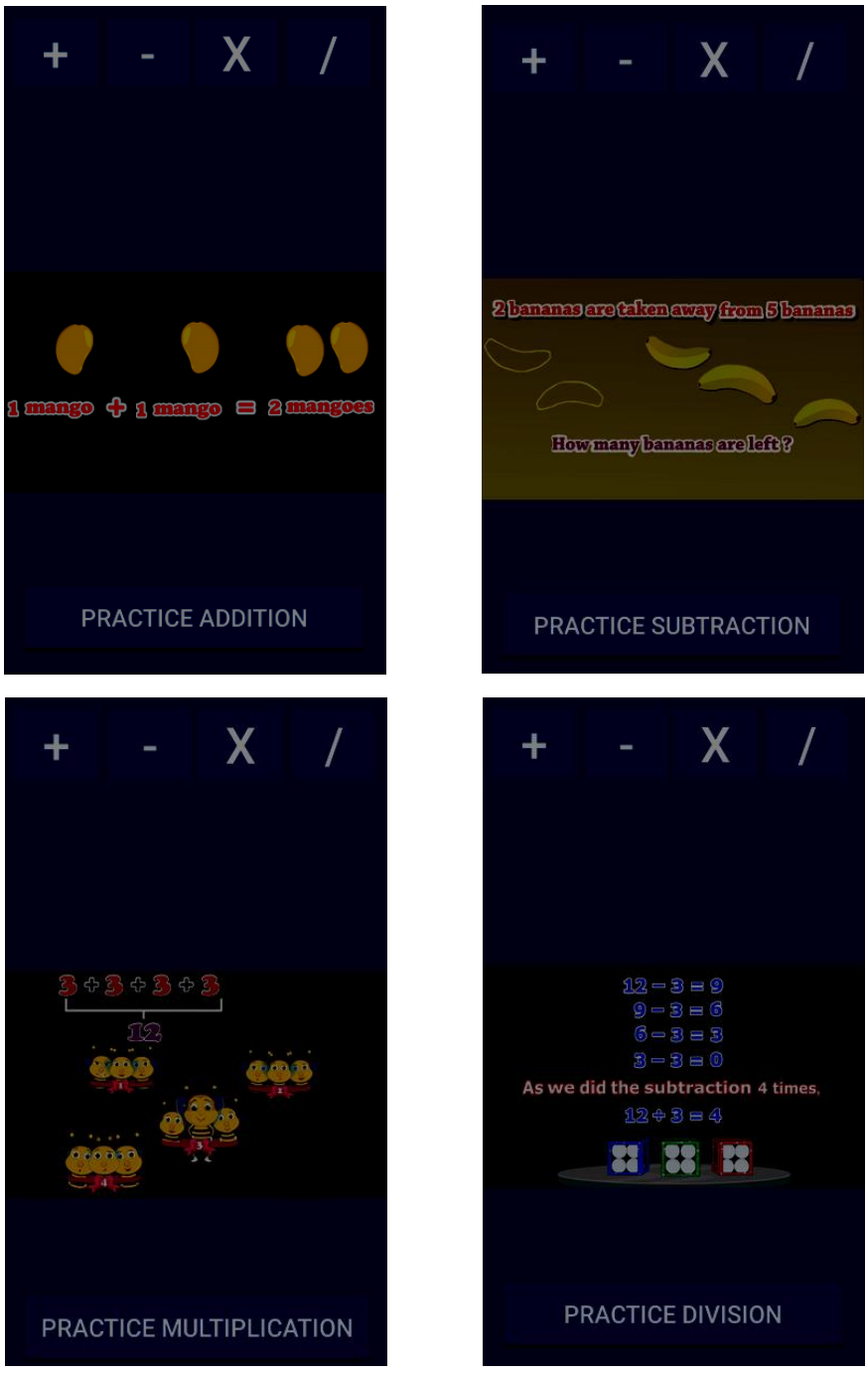

Figure 4.1.2: Tutorials of learning addition, subtraction, multiplication and division

iii. When the practice button is pressed, it goes to the practice session. There are two text views for the correct and wrong answers. After that, there comes a question text and a random list of Array.

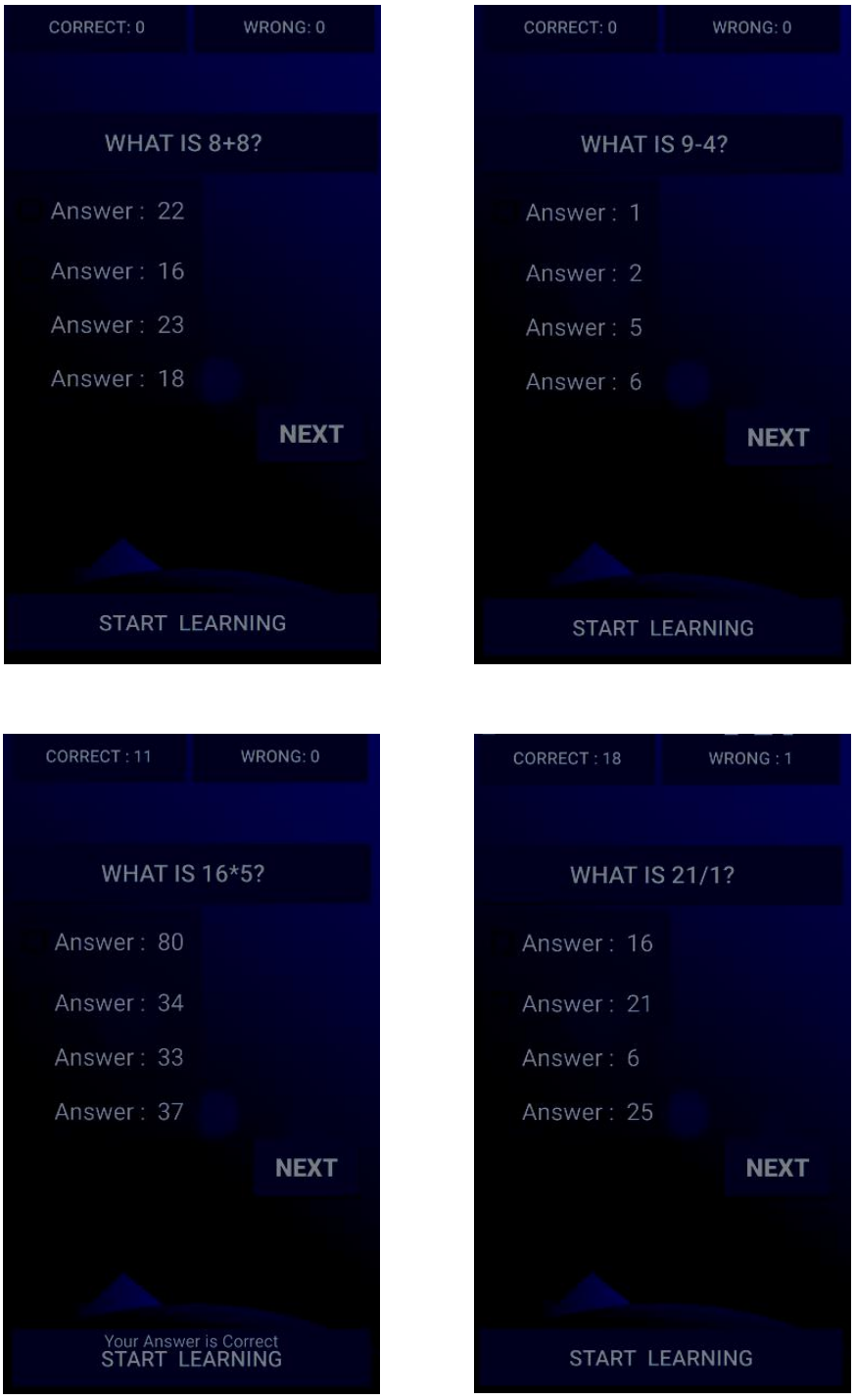

Figure 4.1.3: Practice problems for addition, subtraction, multiplication and division

4.2 Experimental Data

For the four selective mathematical operations, four distinct data tables are made on the basis of the children's response who took part in the experiment to test the prototype.

TABLE 1: EVALUATION OF THE METHOD OF TUTORING ADDITION

Participant No.	Age (Years)	Overall Time Taken (Approx) in Minutes	Total No. of Questions Answered	No. of Correct Answers
Participant 1	7	9	5	3
Participant 2	7	10	6	3
Participant 3	7	9	8	6
Participant 4	8	8	4	3
Participant 5	8	7	7	6
Participant 6	8	9	6	4
Participant 7	8	7	7	5
Participant 8	9	6	10	8
Participant 9	9	6	8	7
Participant 10	9	5	9	8

From table 1, it is seen that the participants took approximately 8 minutes to understand the rules of addition and practice answering around 76% questions correctly.

TABLE 2: EVALUATION OF THE METHOD OF TUTORING SUBTRACTION

Participant No.	Age (Years)	Overall Time Taken (Approx) in Minutes	Total No. of Questions Answered	No. of Correct Answers
Participant 1	7	12	6	4
Participant 2	7	11	5	3
Participant 3	7	13	7	4
Participant 4	8	11	7	5

Participant 5	8	10	5	4
Participant 6	8	9	9	6
Participant 7	8	10	8	6
Participant 8	9	8	10	8
Participant 9	9	8	9	7
Participant 10	9	9	8	7

From table 2, it is seen that the participants took approximately 10 minutes to understand the rules of subtraction and practice answering around 73% questions correctly.

TABLE 3: EVALUATION OF THE METHOD OF TUTORING MULTIPLICATION

Participant No.	Age (Years)	Overall Time Taken (Approx) in Minutes	Total No. of Questions Answered	No. of Correct Answers
Participant 1	7	15	3	1
Participant 2	7	13	2	1
Participant 3	7	14	2	0
Participant 4	8	13	3	1
Participant 5	8	14	4	2
Participant 6	8	13	2	1
Participant 7	8	12	4	2
Participant 8	9	13	5	3
Participant 9	9	11	5	2
Participant 10	9	11	6	3

From table 3, it is seen that the participants took approximately 13 minutes to understand the rules of multiplication and practice answering around 44% questions correctly.

TABLE 4: EVALUATION OF THE METHOD OF TUTORING DIVISION

Participant No.	Age (Years)	Overall Time Taken (Approx) in Minutes	Total No. of Questions Answered	No. of Correct Answers
Participant 1	7	20	2	1
Participant 2	7	21	3	1
Participant 3	7	19	2	0
Participant 4	8	18	2	1
Participant 5	8	17	3	2
Participant 6	8	16	3	1
Participant 7	8	16	2	1
Participant 8	9	13	5	2
Participant 9	9	15	3	1
Participant 10	9	14	4	2

From table 4, it is seen that the participants took approximately 17 minutes to understand the rules of division and practice answering around 41% questions correctly.

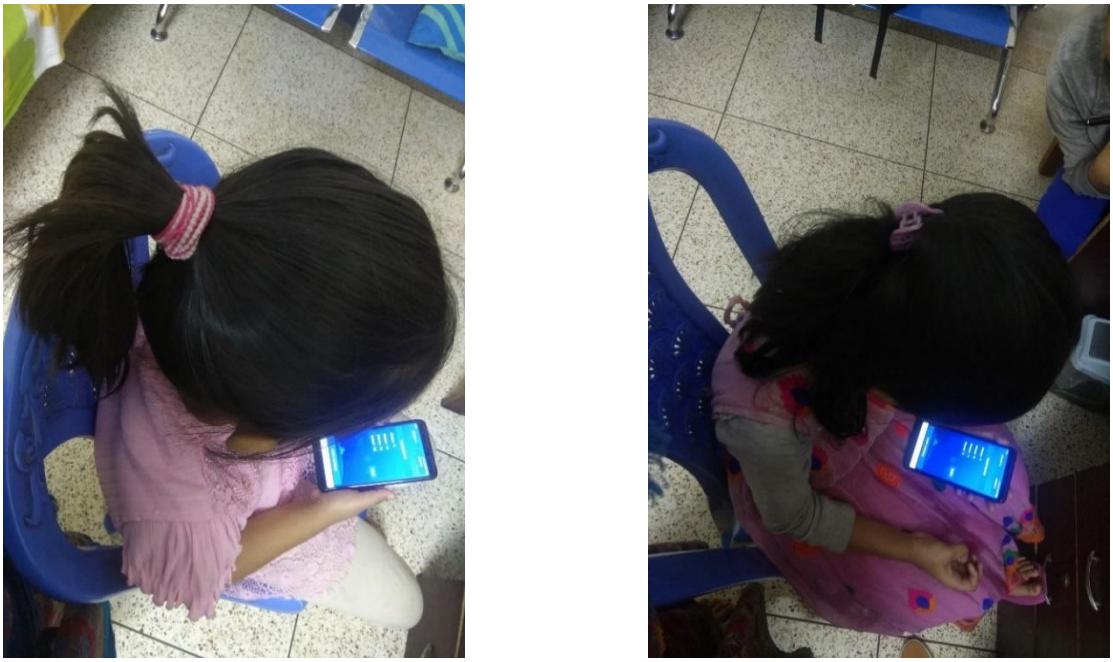

Figure 4.2.1: Two participants are practicing few sums after finishing their tutorial sessions

4.3 Discussion

All the children spent 12 minutes on an average behind each of the methods with an initial interference of an elder person and could answer nearly 59% of the participated questions correctly. Therefore, it can be said that the result of the experiment is positive at some extent. But one thing is evident that they have done quite good in addition and subtraction, whereas have shown weak performances with significantly low scores in multiplication and division.

Since we have made this application only based on our ideas and couldn't take much feedbacks from our target users, the research is not over yet. The options for further experiments in many directions are opened. Because of the time and some other limitations, the amount of our work completeness is significantly less and most importantly we couldn't collect enough children's opinions. An experiment should have been run on more children to come to an obvious decision. But one thing is clear that they need a change in their traditional learning layout or process.

CHAPTER 5

CONCLUSIONS AND FUTURE WORK

5.1 Conclusions

In gamification, it's not mandatory to make a game. In fact, it doesn't even refer or include creating a whole new thing. It's about making an already existing system attractive. It means boosting the effect of an existing vital experience by applying the art of inspiration that makes a game so much engaging.

But there must be a balance between learning and fun. If children indulge themselves too much to extract the entertainment part only and don't get the learning part, it will not be beneficial for them at all. So they should be under the guidance of their guardians or teachers during the learning period to make sure its proper usage.

5.2 Implication for Further Study

Due to some limitations, only four basic mathematical rules are covered. In future, we will try to add more mathematical rules. We will try to update it till mathematics of higher levels. No level up feature is available in this application. Level upgrading approach will be taken. To seek children's attention more, virtual rewarding system can be added. Instead of practicing the typical PBL (Points, Badges & Leaderboards) fallacy, something more innovative as well as not competitive can be brought out. After all, according to Fogg gamification is the usage of proper tools to bring positive behavioral changes in the users.

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