

Matherpiece: An Introduction to Math E-Learning PC Game Application for Grade 1 Pupils



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Abstract: *The purpose of this project is to help and encourage Grade 1 students with the ages ranging 6-7 to improve their math skills and make mathematical concepts more interactive. It is built with the use of a Kinect device with a motion sensor that enables the users to control the game application through hand gestures. The project covers topics like counting, addition, subtraction, patterns, and comparing numbers. The application has lessons with learning activities and quiz as for the assessment. The application can run on Windows OS 10 with a screen display of 1366 x 768. It was developed using Microsoft Visual Studio 2015, C# for the programming language, Kinect SDK for references, and Adobe Photoshop CS6, Moovly and Sony Vegas Pro 14 for the design, videos and audios. The researchers successfully conducted test cases such as the functionality of the overall features, the stress test for stability of the Kinect device and compatibility testing for the software and hardware requirements. The evaluation was participated by ten (10) IT experts and thirty-five (35) end-users comprised of Grade 1 pupils with their parents and Grade 1 teachers. The user's acceptability of the project was based on the criteria of PC Game application such as functionality, engagement, and aesthetics. The overall evaluation results garnered an average mean of "3.68" and a standard deviation of "0.10" with an interpretation of "Highly Acceptable". Hence, participants strongly agreed that the project can be an educational tool in learning basic mathematics for children.*

Keywords— Grade 1, Hand Gesture, Kinect, Mathematics, and Motion Sensor

I. INTRODUCTION

Recent years have seen a quick expansion of computers in households and schools. In consequence, it has become more

affordable to use computer apps to engage students in learning mathematics. Research suggests that the use of educational games is an effective means of improving students' attitudes towards mathematics. It has been shown that educational games attract and gain students' attention contributing to their increased motivation and engagement with mathematics (Libradilla, 2015). There are a number of Math E-Learning PC Game Applications on the market today (<https://www.common sense media.org/lists/best-math-games-for-1st-grade>). Most of these games are designed for mobile devices such as iPad, Android, Kindle Fire, iPhone, iPod Touch, and Android. The games are played with physical interaction with either a keyboard, mouse or touch screen.

Today, with the advancement in technology, utilizing motion-sensors in mobile learning systems have started to evolve. Research indicates that the potential of using motion-sensors in game-based learning could achieve maximum benefits from mobile technology in game-based learning activities. (Skinner, 2013). Kinect is a line of motion sensing input devices produced by Microsoft. It enabled users to control and interact with their computer without the need for a game controller, through a natural user interface using gestures and spoken commands.

In consequence, this study entitled Matherpiece: "An Introduction to Math E-Learning PC Game Application for Grade 1 Pupils", aimed to develop an E-Learning Application that incorporates the Kinect Technology.

A. Objectives of the Project

Generally, a project aimed to develop "Matherpiece: An E-Learning 2D Computer Based Application Game".

Specifically, it aims to:

1. Design an e-learning application with the following features:
 - a. skeletal tracking and hand gestures with the use of Kinect device to control the game that uses two hand commands in answering questions through dragging and dropping of the answer on the placeholder.
 - b. Basic mathematics topics for Grade 1 like Counting Numbers, Addition, Subtraction, Patterns and Comparing Numbers
 - c. Quiz module per topic with five (5) randomly selected questions.
 - d. Lessons in video format about introduction to math topics.

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e. User guides on how to use the application in the form of video and images.

2. Create the application using the Microsoft Visual Studio, C# as the programming language, Kinect SDK for references, Adobe Photoshop CS6, Moovly and Sony Vegas Pro 14

3. Test and improve the software using functionality, and stress testing.

4. Evaluate the acceptability of the application software based on the PC Game Criteria such as Functionality, Engagement, and Aesthetics.

B. Scope and Limitations of the Project

Matherpiece is an e-learning PC-based application game that focuses on the introduction to mathematics with lessons like Counting numbers, Patterns, Comparing numbers, Addition, and Subtraction. In every topic, there is a category to choose between Lesson and Quiz. The Lesson contains a video presentation about a specific topic in math while the Quiz module has five (5) randomized questions. Grade 1 pupils are the target user of the application with the assistance of their teacher and parent. The application is connected with a Kinect device which allows the user to physically interact to the game that can detect the two hand gesture that will control the game by just tap, drag, and drop of the images and buttons. The technical requirements that can be used to run the project are Windows 10 with Kinect SDK version 1.8 and a PC with 4GB RAM, and 1366 x 768 screen resolution.

The Kinect device only detects two hand gestures of the player at the minimum distance of 1.47 meters and the maximum distance of 3 meters. 3. The app does not have Back-up data/ Save game progress. This application is an offline game.

C. Significance of the Project

Matherpiece is a tool for children under Grade 1 level to make their basic mathematics learning experience engaging and interactive.

The following will benefit the project:

- Grade 1 Pupils. Learn the step by step basic mathematical sequence like counting, addition, subtraction, patterns, and comparing numbers in an interactive approach using a motion-sensing device.
- Grade 1 Math Teachers. This can assist teachers in delivering and teaching introduction to math to children in an interesting way.
- Parents. The app can aid parents in teaching their children mathematics at home.

II. METHODOLOGY

This chapter is accordingly concern with technology applied, the execution of the processes and the outcome of the research project. This includes the requirements, design tools, development methods, testing and evaluation plan, and procedures performed.

A. Design

Demonstrates the program flow of interconnecting them through arrows. It is usually used as a representation of each process executed within the program.

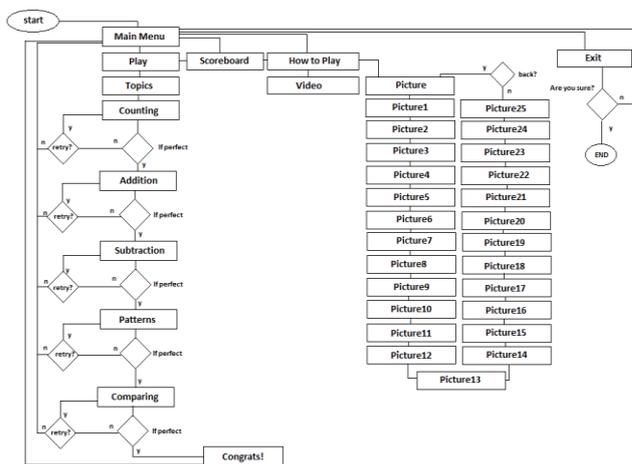


Fig. 1. Flowchart of Matherpiece

In Figure 1, illustrates the general process of how the Matherpiece worked. First, the user would have to stand in front of the Kinect sensor for the recognition of the hand skeleton. The application will proceed to identify and verify the hand gesture as the command. Afterward, the application will examine the stated command requiring it to proceed or open a particular function.

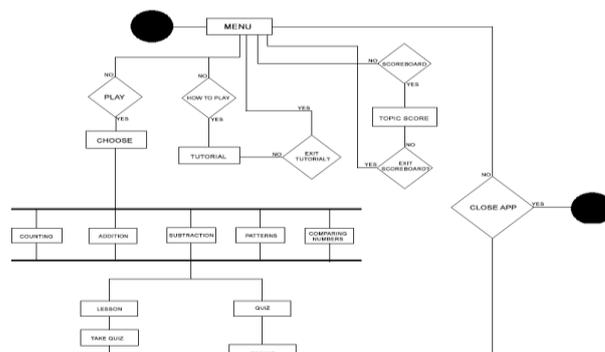


Fig. 2 Activity Diagram of Matherpiece

The user will specify a command, which is verified whether it is play, scoreboard and how to play. If so, the software will run the application and direct to the form manipulated. If the user decided to exit the application there will be a display picture asking a question if you are sure to exit the game that is answerable by yes or no. If yes, the application will be closed. However, the user may also keep operating the application while still open.

B. Development

This section discussed the development of the project using different software and hardware. The development phase is where the system being built along with its functions and features. Software Specification. Windows 10 OS was used in developing the game. Microsoft Visual Studio 2015 with C# was used as the primary tool for programming. Kinect SDK version 1.8 for creating the main functions of the app and make use of the motion sensor, Adobe Photoshop CS6 for quality of photos and UI designs. Moreover, Moovly and Sony Vegas Pro 14 were used for audios and videos.

Hardware Specification. A laptop was used in creating the application is with specifications of Intel Core i5 processor, Turbo boosts up to 2.20 GHz with 4GB RAM and 1366 x 768 screen display.

C. Test Plan

This was conducted to verify the performance of the software. This phase used the Functionality and Stress test cases. Functionality test was used to check the main parts of the app specifically the buttons, modules, and interfaces if functioning as intended. The Stress test was conducted to verify the capability of the Kinect device to accept and identify hand gestures. The test activity was participated by the developers, a technical critic, and a Grade 1 math teacher.

D. Evaluation Plan

The evaluation activity was performed to validate the user’s acceptability of the application. The evaluation instrument used was based on PC Game Applications criteria of Functionality, Engagement, and Aesthetics. Functionality focuses on the performance and ease of use of the app, navigation or controls, customization of the settings and adaptability in the recommended technical specifications; Engagement criterion assessed the entertainment value, interest of the user, objective met, achieved learning goals of the app, reliable subject presented, appropriate target group, and scoreboard as feedback; and Aesthetics was based on the appropriateness of layout, the quality of graphics, and the visual appeal. The evaluation respondents were ten (10) IT experts specifically in the field of game design and development, and application development, and thirty-five (35) end-users composed of ten (10) Grade 1 teachers, and twenty-five (25) Grade 1 pupils assisted by their parent.. The final evaluation results are based on the weighted mean and standard deviation. The interpretation of the final result is from the prescribed Likert scale with “Unacceptable”, which means the lowest and might have failed to execute its main functions; “Fairly Acceptable” somehow the system has executed but lack of consistency to function well; “Acceptable” the features of the application almost meet its expected result and lastly “Highly Acceptable” which means the highest and the overall functions and objectives of the application works smoothly.

III. RESULTS AND DISCUSSIONS

A. User Interface Design



Fig. 3 Connect the Kinect

Figure 3 shows a Kinect device is connecting the program before play the game. The main menu has the play, scoreboard, how to play, and exit button.



Fig. 4 Select Topic

In the Play module, Choose Topic will let the user select a topic. The topics are Counting, Addition, Subtraction, Patterns, and Comparing Numbers. Initially, the last four topics are locked as shown in Fig. 4. These will be unlocked only once the quiz under the selected topic was successfully achieved a perfect score.



Fig. 5 Lesson

This module has the tutorial of a specific topic in a video format. The video has controls as options to play, pause, and stop. This includes a Take Quiz button to direct the user to the Quiz mode.



Fig. 6 Quiz Game

In the Quiz module, the app will let the user answer five (5) questions using hand gestures. The choices are located at the bottom part of the module and will be moved to the blank space that indicates “place answer here”. In every correct answer, this will have 5 points each.

As shown in the figure above, a player tries to pick and place his chosen answer using the motion- sensing device.



Fig. 7 Level Complete

After the user finished the quiz, the app will show the completion of the level. This shows the score with the number of stars earned. This also includes the Continue and Home buttons. The Continue button gives the user the option of proceeding to the next topic while the Home button will go back to the main menu.



Fig. 8 Scoreboard

This module shows the progress of the user in each topic to know which area should be improved.

B. Test Result

This shows the overview of the result of the test conducted. The developers used two (2) test instruments, the functionality and stress test. Test results were successfully got 100% in the test tools used.

Table 1 Overall Results for Functionality, and Stress Test.

Test	Pass	Fail	Total No. Of Cases	Percentage
Functionality Testing	113	0	113	100%
Stress Testing	6	0	6	100%

Table 1 shows the overall test results from the developers, a Grade 1 teacher, and a Technical Critic. The table contains three (3) testing which was Functionality, Stress, and Compatibility Testing. It is successful testing because for all the test the researcher's received 100% passing results same in the technical adviser.

C. Evaluation Result

The evaluation results were gathered from forty-five (45) participants, comprised of ten (10) Grade 1 teachers, twenty-five (25) Grade 1 pupils with their parents, and ten (10) IT experts.

Table 2
Overall Evaluation Results.

Level of System Acceptability	Mean	Standard Deviation	Interpretation	Rank
Functionality	3.65	0.14	Highly Acceptable	3
Engagement	3.67	0.09	Highly Acceptable	2
Aesthetics	3.72	0.10	Highly Acceptable	1
Average Mean and SD	3.68	0.10	Highly Acceptable	

The highest rank among the criteria is the *Aesthetics* with a mean of “3.72”, and “0.10” standard deviation (SD), this shows that the arrangement and size of buttons, icons, menus are displayed appropriately, the resolution of graphics used is high, and the app is visually appealing. While *Engagement* with a mean of “3.67” and “0.09” SD got the 2nd highest rank, this means that the app is fun and interesting to use, the learning objectives are clearly achieved, the goal of the gameplay is clearly stated and measured, the topics are presented well, the contents like visual information, language and design are appropriate for the Grade 1 pupils, and lastly, there are opportunities for users to receive feedback on their performance through the completed levels and scoreboard. The last rank is the *Functionality* criterion which earned a mean of “3.65” and a “0.14” SD, despite being the last rank, this criterion still achieved a beyond the acceptability level, this still proves that the app features and components work accurately, easy to use and understand, moving between screens and modules is accurate, provide preferences for features, and the software capable to run in recommended platform. All criteria were interpreted as “Highly Acceptable” which means that the MATHERPIECE application is “Highly Acceptable”. The application is very entertaining to use and the content is appropriate for the target users.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

The project was successfully developed “Matherpiece: An Introduction to Math E-Learning PC Game Application for Grade 1 Pupils. The app was designed with the following features such as a program that has a skeletal tracking and hand gestures with the use of Kinect, learning module for Grade 1 pupils with topics in introduction to mathematics like Counting Numbers, Addition, Subtraction, Patterns and Comparing Numbers, Quiz module per topic with five (5) randomly selected questions and user guides on how to use the application in the form of video and images. The software was create using the Microsoft Visual Studio with C# as the programming language, Kinect SDK version 1.8 for references, Adobe Photoshop CS6, Moovly and Sony Vegas Pro 14 for the user interface design and multimedia contents. The app was tested and improved with 100% passing score through the functionality, and stress tests. Lastly, this was evaluated by forty-five (45) respondents using the PC Game Criteria such as Functionality, Engagement, and Aesthetics. The evaluation results from an overall mean of “3.68”, an SD of “0.10” and interpreted as “Highly Acceptable”.

Based on the test and evaluation results, the end-users agreed that the application can be an alternative tool to teach the introduction to math for the Grade 1 pupils.

B. Recommendations

Based on the findings and conclusion presented, the following recommendations are made for the future feature enhancement of the project.

1. Add math topics like currency, time, place value, measurements and etc.
2. Make the use of other controller devices like gamepad, joystick, and remote.
3. Back-up data/ Save the game in the database for the continuous progress of the player.
4. Add mini-games like puzzles and connecting dots.

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