A Gamified Educational Learning Module for Core Subjects in an Elementary Level

Eric B. Blancaflor, Kim David G. Camaongay, James Adrian S. Chua, and Genesis A. Echanes

***Abstract*—Presently, many students are unmotivated and lack interest in studying that they would prefer playing games or watching movies. It would be beneficial for the students if they were playing while learning at the same time. As the team considered the current pandemic, COVID19, can also be a case to be considered on hindering a lot of students to study in their own respective schools. The team decided to create an educational game implementing a different learning process for the students. The game is not only developed to help the students on learning but also engages them and tests their cognitive abilities on solving different puzzles. Taking the advantage of being able to be exposed in a gamified learning at their own home, it can assist the teachers in refreshing or enhancing the students' knowledge.**

***Index Terms*—Educational game, cognitive abilities, gamified learning.**

I. Introduction

Digital games are popular to the younger generation, because of how easily accessible it is. Anyone with a gadget will have a game on it. There are some digital games that require wireless connection, and some do not, the games that require wireless connection will need internet or data. The reason for having these games in the users' gadget is that it serves as a form of entertainment to the user or even just to pass the time.

Educational game is a part of digital games where it will give educational facts to the user about specific subjects or topics like History or Mathematics. These types of games help the users' brain exercise their problem-solving skills, common sense, and knowing the past.

Interactive game is a genre of educational games. It is related because of how these types of games challenge how the user will solve, think, respond, and interact with that problem in the game. Experiencing those challenges in the game will help the user develop new skills, knowledge, and attitude. Being an interactive game will help the user in decision making, where they will see if the answer is right or wrong.

According to the survey results of Kristyn Nika Lazo (2013), the NSO said that 51.3 percent of the children surveyed aged 6 to 11 claimed that they had no ―personal interest‖ to go to school. Children aged 12 to 17 gave the same reason that they lack personal interest to go to school, which is around 38 percent [1]. Based on this information we can see that there is a reason for students not being motivated going to school. There are many reasons to vary, this maybe those students see learning as a chore or there are more interesting things to do at home than in school. We can also come up with an idea that in their home their things that interest them more, like gadgets with installed games, internet or Television shows. This study was motivated by most frustrated readers, we can have a grasp that it can be that they are socially isolated. Being socially isolated is not really a bad thing, but the only thing is that they do less social interaction and interaction is a form of learning where you can ask another person on how to do this and people learn from that.

According to Sara Soliven De Guzman (2010), Philippine education is in crisis. This is manifest in performance indicators that reveal high rates of drop-outs across the system, poor performance in national and international achievement tests, poor reading abilities and functional literacy of older students, lack of student preparedness for study in high school and university as revealed in diagnostic tests and entrance exams, and the recognition by the business community of declining abilities of Filipino workers in language proficiency, technical skill and ability to think and solve problems [2]. There are many causes that results on degradation of the student 's performance and one of it is that the student 's tends to go to a game center instead of going to school because the temptation of playing games is higher than sitting idly on a chair listening to a boring discussion that doesn 't hit the student 's sense of achievement.

Gamification is the use of game design aspects to non-game situations. While gamification isn't a new notion, new dynamics are emerging that may lead more businesses, schools, and libraries to explore incorporating game-like components into their future initiatives. There has been a huge acceptance of using cellphones and playing games on a regular basis, in addition to more generation Y or millennials entering higher education and the employment. [3].

What persuaded the researchers to strive for the project is that there are surveys that claimed that in the Philippines students had no personal interest to go to school. There are a lot of reasons why they do not like it but the thing that the team can contribute is to make a system where learning can be not a chore. Moreover, is the inspiration of those related studies which believes that gamification in contents may assist learners in their interaction to learning.

A. Research Question & Objective of the Study

This is study aims to explore how a gamified application be effective in the aid of teaching and learning Math, Science and English subjects in an Elementary level. Many students are unwilling to participate, easily get bored and distracted in

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class. The purpose of the project is to create a way of motivating students to learn and study by developing a computer-based game. A game that will make students engage in doing their seatwork, where it will grab their attention and will also help the teacher know which topics, students are having a hard time.

B. Scope

The project aims to create a computer application that is similar to common educational games, but the difference is the feature of the game. This will enhance the student's curiosity to the subject and will make them interested in class. The application will serve as an extra class for students to gain additional knowledge about the lessons. It will also record the information of the users like scores and the subjects, which will be a guide for the teachers on what part of the subject does the student have a hard time understanding. It can also show their scores using the scoreboard in game.

C. Significance

The application would serve as an extra material for learning that would let students interact with one another while learning. The recorded information like the scores would serve as a guide for the teachers; to let them know what part of the subject their students have a hard time understanding.

II. Review of Related Literature

Games integrated with education can be seen as useless by most people in the past but with the current time, games can become another world where a person can see another reality. A reality that gives a person confidence, courage, and knowledge. Integrating education in a game is a bit complex but a chance for another world waiting to be ventured [4]. In a study made by Karl Royle titled, "Game-Based Learning: A Different Perspective", it was stated that the game should be engaging that can make the user immersed in it while obtaining new knowledge. The game must be well-balanced between being educational and entertaining [5].

In another study made by Riska Ayu Ardani and Wahyu Setyaningrum titled, "Game-Based Edutainment Media using Guided Discovery Approach: What teachers say?", it explained that guided discovery approach is a better method to implement in an educational game because a student might not be interested on playing the game due to the student's capability on understanding Mathematical concepts inside the game. With the guided discovery approach, the student could get instructions especially on Mathematical concepts that really needs to be explained and difficult to understand only by oneself [6]. On a paper written by Mihaela Banek Zorica titled, "Edutainment at the Higher Education as an Element for the Learning Success", it stated that learning is great when people explore things while enjoying the process. Learning through different methods creates curiosity that can make the students interested to explore another world of learning [7].

In a study by Setyaningrum *et al*, 2018, two things that were disregarded from the students for education. These two are the interest and motivation of a student. Lectures cannot retain any important knowledge if the student doesn't give any attention to it. The discussion of the teacher of a topic is also an important factor for making a student interested in the lecture and be motivated to participate as the discussion move on [6].

On the other hand, in the study entitled "Edutainment at the Higher Education as an Element for the Learning Success", shows the result of applying educational material into a game as a learning process. Every person nowadays has a piece of basic knowledge of certain technologies. Same with the students, the growth of a student in the present is already mixed with the use of different technologies. Considering the mental development of a student, edutainment encourages the students to have fun while learning through playing the game. Learning through a game must be relevant to facts that can be applied on real life, contemplating the rate of the student to grasp and the difference of how a student absorb the knowledge imparted by the game [7].

In a study by Chen *et al*., it addresses the need for gamification techniques that encourage high-quality annotations that can improve students' reading comprehension. Future studies were recommended to increase both annotation quality and the relationship between reading achievement and gamification mechanisms to better associate game elements and learning performance [8].

Based on those related studies we can see that there is a reason for students not being motivated going to school. There are many reasons to vary, this maybe those students see learning as a chore or there are more interesting things to do at home than in school. We can also come up with an idea that in their home their things that interest them more, like gadgets with installed games, internet, or Television shows. The game can also show on what subject or topic a student is having a difficulty on understanding and the teacher make a solution for it in the game. The student's growth can be enhanced through the game with the proper guidance of the teacher. Furthermore, studying on appropriate game elements for learning is an opportunity that this study may explore as well.

III. Methodology

First phase used in this study is data gathering. Gathering data using the found review of related literature and review of related systems. Interviewing students, teachers, and parents to collect their opinions on the approach of the project. Next stage is knowing design requirements. All collected data will be considered and will serve as required functions for the system. The chosen requirements are to be applied as an objective of the system. Then Development and testing is the third phase. Testing is done along with select test audiences to be able to also see the project from a third party 's objective point of view. Then the last phase is the Implementation. In this phase, the end user will be using the system. And the developers will need to maintain the system if the user encounters problems.

A. Current Process Flow

Fig. 1 shows the current process flow of activities of students in school. These are the standard way of what students do in school. The teachers give a lecture to the students and after the lecture they would have an activity, from that activity the students will see their scores and will let them know if they are ready to take the quiz or not. The group was able to obtain this information by interviewing a principal of a school

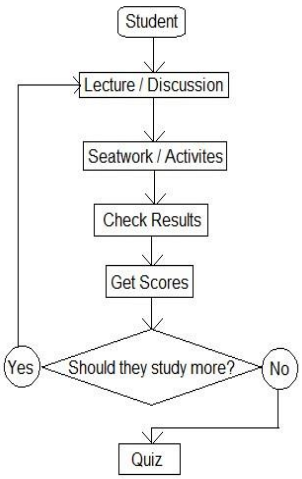

Fig. 1. Current process flow.

B. Proposed Design

Fig. 2 shows the proposed process for the school activities of students. It may look like Fig. 1, but the change that the group proposed is to let the teacher have an alternative method for learning. Where they can use the game for school activities. The game will not be a replacement for the standard learning of the students but as a supplementary class.

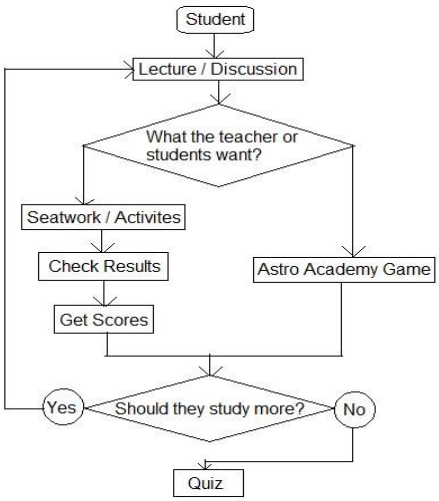

Fig. 2. Proposed process flow.

The Use Case diagram presented in Fig. 3 shows the students and teachers on what functions they can do in the system. It also shows what their role is in the system. The student and teacher can only access these functions if they login with the right account type. If they login as a student they can only play the game, while if they login as a teacher they can modify the contents of the quizzes and lessons for the students. Students can choose a teacher, choose a subject, view a lesson, play the quizzes, and view their scores. Teachers can add a new quiz, edit an old quiz, add hints in the quiz, delete a quiz, add questions, delete questions, add lessons, edit lessons, delete lessons, and see the scores of the students.

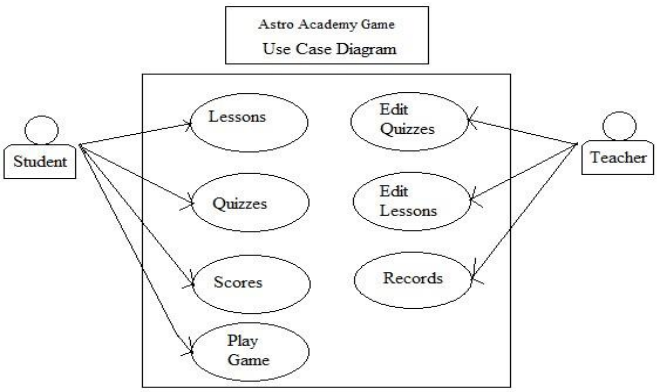

Fig. 3. Use case diagram for the game.

C. Use Case Diagram

When the user logs in as a teacher, the Fig. 4 teacher menu illustration will be visible. Here they will have the option to view the score of the students who have taken the quiz which is in the quiz records. The lesson editor option is for teachers to make a presentation slide show style for their lesson to be shown on the student's side. The question editor option is where the teachers will put their questions and answers, then the system will gamify those questions, which will then be a game on the students' side.

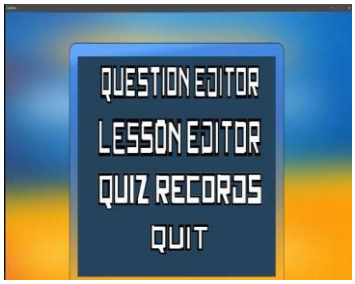

Fig. 4. Teachers menu.

Fig. 5 presents the site map which shows what is inside the Astro Academy Game. Inside the proposed gamified module design, it has different functions where the user needs to first register. After the registration is the login and from there, they will have to login based on what account type they have registered. When logging in as a teacher they will have access to changing the contents of the quizzes and lessons. On the student side they will only have access to viewing their scores and lessons and playing the game.

The difference of the proposed process to the current is that the researchers added an educational game to the decision of the teacher. Instead of doing it on paper maybe the students can do it through a game. The educational game has a login system where they have to login as a student or teacher. The teacher side has a quiz maker, where they can prepare the question and answers to be gamified. They also can see the scores of the students who have taken the quiz. The student's side has a quizzes option in the menu, what is

inside of it is the gamified questionnaires of the teachers. Playing the game and answering the questions that the teachers prepared will be recorded and be shown on the teacher's side.

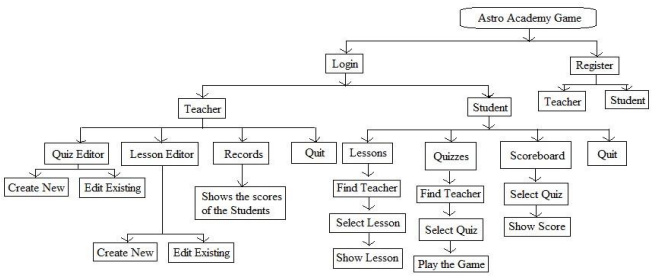

Fig. 5. Proposed game design site map.

Fig. 6 presentation is visible to users who have logged in as a student. In the menu for the students, they will have to control the astronaut and go to the different options. The options that are available to them are the two (2) robots and a board that says score. When going to the robot with a lesson sign will show them the lessons prepared by the teachers for the students. The robot with a quizzes sign option is where the student gets to play the game, here it will show the questions prepared by the teacher, but it is in gamified form. The last one is the score board and when the students finish playing the quizzes, they get to see their scores here.

Fig. 6. Students menu.

Fig. 7 shows a sample scene of one of the mini games that a student user will encounter when they choose a quiz that they will play from the quiz board in the classroom hub. When the student chooses a quiz, the game will randomly choose a mini game for each question in the quiz. The questions will then be presented to the player in the form of a mini-game and then they must answer the question by completing the objective of the current mini-game to proceed to the next question which will be presented in another randomly picked mini-game.

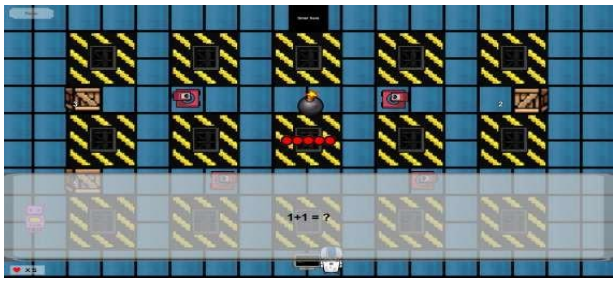

Fig. 7. Sample of the game.

IV. Test Results and Findings

Astro Academy design in this study is an educational top down 2D puzzle game that will help you study and apply what you have learned in school while also having fun. The target user plays as an astronaut trainee almost ready for launch but first and must be able to prove ready for space travels. The game design has puzzles, answer questions and overcome challenges prepared. The game is an adventure-based learning game for kids with a variety of mini games that would keep kids engaged while also helping them develop their reading, math and critical thinking skills. The story is minimal with the setting being a school for space explorers and the player character is a cadet trying to finish his/her training. It can be used both inside and outside the classroom. It is not made to totally replace normal classes but as a reinforcement of the regular lessons. The game can be given to be about specific topics and integrated in the mini games due to the questions being editable

After the prototype development a unit and user acceptance test were conducted. The test was done in two (2) ways and those were the user acceptance test and unit testing. In the user acceptance test the researchers looked for five (5) students that are grades five (5) to six (6) and one (1) teacher. The unit testing is the part where the team groups the computer program into modules and tests it for how many times.

Unit testing is a type of test where the researchers grouped the computer programs into modules and follow the step-by-step procedures, to know if they encountered any problems in the system. On their side they had no problems. The only issue was they needed stable internet connections for it to work.

User acceptance test is where the researchers looked for the six (6) testers, specifically students and a teacher. What they did is give an account to the teacher and students and test each function of the system and know what their opinions are on it. The teacher is mostly content with the design of the system. While the students have different feedbacks some were pleased with the designs and some students show interest in playing more of the game. Same with the unit testing if they do not have stable internet, they will encounter some problems.

The collected results of the unit test and user acceptance test are then compiled, which gives the group ideas of what to change or improve in the system. In the results of the unit test, the group was not encountering problems in testing the functions. The minor problem that they had was that some of the data was not being stored, the cause of this is that the tester did not have a stable internet connection. User acceptance results had two (2) tests which are the tests for the student and teacher side. In the teacher side test, it had no issues in performance, they were pleased with the design and problems only occurred when the internet was having connectivity issues. The student's end of the test was pleased with the design of the game, some were having a bit of trouble navigating through the game, and almost all the students were satisfied with the performance and interface of the game.

TABLE I: SUMMARY OF USER ACCEPTANCE TESTS — ASTRO ACADEMY (TEACHER)

System Design		Rubric				
No.	**Criteria**	**5**	**4**	**3**	**2**	**1**
1	The clarity of the text in the program.	100%				
2	The buttons in the program are user-friendly.	100%				
3	The colors in the program are pleasing to the user and good for the program.	100%				
4	Navigating through the program with ease.		100%			
5	Consistency of the colors and styles used in the program	100%				
6	Position of the buttons and text.	100%				

TABLE II: USER INTERFACE (TEACHER) USER ACCEPTANCE TEST

USER INTERFACE			
No.	**Criteria**	**Yes**	**No**
1	Graphics and Display		
2	The program is displayed in a landscape orientation.	100%	
3	The texts are not out of bounds from its intended position.		100%
4	Consistency of style and visual effect used in the program	100%	
5	The text does not cover from each other.	100%	

TABLE III: USER ACCEPTANCE TESTS — ASTRO ACADEMY (STUDENT)

System Design		Rubric				
No.	**Criteria**	**5**	**4**	**3**	**2**	**1**
1	The clarity of the text in the program.	40%	40%	20%		
2	The buttons in the program are user-friendly.	40%	40%	20%		
3	The colors in the program are pleasing to the user and good for the program.	40%	20%	40%		
4	Navigating through the program with ease.	20%	40%	40%		
5	Consistency of the colors and styles used in the program	40%	40%		20%	
6	Position of the buttons and text.	40%	40%	20%		
7	The mechanics and controls of the game are easy to understand.	40%	40%	20%		
8	The game is interesting that it would make the player to play it again.	40%	40%	20%		

As shown in Table I, Table II, and Table III UAT results, the teacher is mostly contented with the system design with only the navigation of the system got a one grade lower from the other criteria, the user interface also got a good result except from the position of texts and lastly, the teacher is well-pleased for the platform performance despite on the part of having errors due to the disruption of internet connection. While the students have clearly different feedbacks from the test in the system design criteria, almost half of the students (40%) say that the clarity of the text in the program is easy to comprehend, the buttons are user-friendly (40%), colors in the program are pleasing to the user and good for the program (40%), and a little bit of trouble on navigation (20%). Also, the students (40%) are pleased with the consistency of style and visual effect applied on the application, and the position of the buttons and texts (40%). On the other hand, almost all the students are contented on the user interface and platform performance.

As shown in the results, some of the students showed interest in playing more after the initial tests. This shows that the game can grab their attention, though for how long, it remains to be seen.

V. CONCLUSION AND RECOMMENDATION

The use of the application, Astro Academy: Ready for Take-off or games with a similar educational nature could help schools provide an engaging learning experience for students. Using computers and entertain9ment, it can be shown to students that learning can also be fun and enjoyable.

With the completion of the project and the data collected, if future researchers are interested in working on a similar project, to work together with the teachers and school to create a better and engaging way of learning for the students. In that way, both the school and the application might be able to attract more students by knowing what it is they need. The researchers also noticed that the gameplay design of each minigame should be related to some degree to the topic of the curriculum. Then also add more minigames to reduce the repetition to students. The quizzes of the game are multiple

choice only, the team recommends supporting other question types like matching type, Identification, enumeration, and other types relating to quizzes.

The study also recommends having a stable internet connection when using this application (Astro Academy: Ready for Take-off), to avoid unsaved data. The application is using a Firebase cloud database and during the tests the team was encountering problems in saving data, so the team would like to recommend looking for other database systems. Other things that could have been added are more appealing designs to the game to attract more attention from students as well as more different types of questions in the game (i.e., matching type, identification, etc.) to enhance the difficulty and variation and lastly, a leader board to create a friendly competition between students in game, to have an overall better playable experience. Moreover, enhancing security features is highly suggested. Anyone working in education should be cautious when engaging in online activities since they may not realize they are becoming a victim of a cyberattack [9].

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, J.A.C., K.D.C., G.A.E., and EBB; methodology, J.A.C., K.D.C., G.A.E.; resources; J.A.C., G.A.E.; writing—review and editing, K.D.C., E.B.B.; project administration, K.D.C.; All authors have read and agreed to the published version of the manuscript.

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