

# Mathematics Integration on the Development of a 3d Action Role-Playing Game: The Light of End



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## ABSTRACT

The game entitled “Mathematics Integration on the Development of a 3d Action Role-Playing Game: The Light of End” used a 3d graphic presentation of characters, equipment, quest and monsters that were rendered using two powerful software: Unreal 4 and Blender 2.8. The researchers developed the base gameplay systems in C++ using Unreal 4. It is an action role-playing game with a combination of mathematical operations like addition and subtraction that the players need to solve to gain player’s stamina during combat battle. This helped gamers and students in the study of simple addition in mathematics because they need to answer the problems as quick as possible. The action role-playing game is based on the Philippine myths where characters like IbongAdarna, AnitunTabo, Maria Makiling, Bathala and Sitan were created, and proper blending / textures were carefully applied. This game has an open world where various quests can be selected like Forest, Caves, Castle and Ice Lands. Each quest contains different monsters and Boss. The player’s goal is to destroy or kill all the monsters and the final stage is to defeat the Boss during combat battle. Solving the addition problem that will appear during the battle will help the player to regenerate stamina that will surely help in defeating the Boss.

Thus, this action role-playing game helped the player to develop critical thinking skills by solving addition problems and continue the quests successfully. Various assets / materials for the player to use were carefully designed and proper effects were applied. The game can be accessed even without internet connection. This is good for those students or players that would like to play the game but lack of data or no access to internet. Rad Methodology, which serves as a guide and steps in the development of the

under each phase: Planning for requirements, User Interface Design, Construction and Cutover.

The evaluation of the respondents included seventeen (17) IT professionals, fifty-four (54) IT students, twenty-eight (28) Bulacan State University (BulSU) students, and ninety-one (91) non-BulSU students. It also demonstrates the interpretation of the mean distributions, which varies from

Bad, Fair, Good, Very Good, and Excellent as the highest interpretation. The researchers devised an assessment instrument that is based on the Software Quality Model following a five-point Likert scale. The game got a computed total mean score of 4.76 with an Excellent evaluation.

**Key words:** ARPG, game-based learning, RPG

## 1.INTRODUCTION

Role-playing games are one of the most popular game genres, and they also happen to be one of the most diverse. In addition, they’ve been built for or ported between any current game hardware platform, as well as tabletop and live-action variants. The game genre was a major source of inspiration for the early development of computer games, and it continues to have a significant influence to this day. The role-playing game industry was the fourth largest segment in the global video games market in 2019, accounting for 9.4% of the total, and it is projected to rise at the highest rate of 9.2% between 2019 and 2023 [1].

Even though many parents are worried about their children playing RPGs, and despite a lot of negative publicity, RPGs have a lot of advantages. Here are some of them: Female players have improved spatial thinking abilities. The desire to form new friendships and put social skills into effect. This is especially beneficial for people who are awkward or lonely. Empathy for people with different lifestyles or appearances has increased. A player will be able to learn what life is like for another person by adopting a new

persona. When players develop complex solutions to ongoing problems, they develop strategy and critical-thinking skills.

Learning simple math can be integrated to a game [2]. He emphasized that students may use games to learn about basic number concepts like counting sequences, one-to-one correspondence, and computing strategies. Students can learn about number combinations, place value, patterns, and other essential mathematical concepts by playing engaging mathematical games.

In this research, the researchers created a role-playing game with an integration of simple math addition problems. The researchers believed that solving math problems while playing games gave an opportunity to the players to have fun and at the same time practice their mental computation. In this game, the players need to solve an addition problem very quick to gain stamina that will be needed to win in a combat battle.

## 1.1 STATEMENT OF THE PROBLEM

This study is designed to develop a role-playing game entitled Mathematics Integration on the Development of a 3d Action Role-Playing Game: The Light of End

Specifically, it seeks to find answers on the following questions:

- 1.1.1 How to design and develop an Action Role-Playing Game with the combination of simple mathematical concepts?
- 1.1.2 How to integrate the following significant features of the game:
  - 1.1.3.1 Character Development;
  - 1.1.3.2 Exploration / Adventure;
  - 1.1.3.3 Strategy Combat; and
  - 1.1.3.4 Math Addition Problems?
- 1.1.3 To evaluate and assess the developed game in terms of the following Software Quality Evaluation Criteria:
  - 1.1.4.1 Environment;
  - 1.1.4.2 Concentration;
  - 1.1.4.3 Challenge;
  - 1.1.4.4 Player Skills;
  - 1.1.4.5 Control;
  - 1.1.4.6 Clear Goals;
  - 1.1.4.7 Feedback; and
  - 1.1.4.8 Immersion?

## 1.2 REVIEW OF LITERATURES AND RELATED STUDIES

### 1.2.1 Conceptualizing Games and Simulations in Education

The use of simulations and role-playing in the classroom is not a new trend. For decades, teachers have used Model United Nations, historical re-

enactments, mock trials, and other dramatic simulations. What's new is that the simulation is packaged as a game and is played over a long period of time, often the whole school year [3].

Dungeons & Dragons, the classic role-playing game (RPG) that is experiencing a recent revival, owes a significant debt to this particular union of role-playing, storyline, and game. D&D popularized and pioneered a slew of RPG conventions that are now commonplace in video games and tabletop games, such as experience points (XP), levels, loot, character classes, and boss battles. The researchers used this idea to include leveling of characters, collecting assets and defeat the boss during boss battles which are the most basic composition of a certain game.

### 1.2.2 Effects of Storyline

The priority in game development is to tell a story: that is the project's primary purpose, and games have been chosen as the story's delivery mechanism [4]. Stories and games have always had an acrimonious relationship. Designers have often written stories into their games, giving the player a set starting point, a narrative route to pursue, and a predetermined ending. Simultaneously, many players flocked to games due to their lack of narrative structure; a game experience is an opportunity to construct a plot, not to send oneself to an unfinished novel by a designer. Role-playing is also a component of many other experimental teaching methods, such as process drama and critical inquiry [5].

### 1.2.3 Game-Based Learning

Game-based learning is the borrowing of some gaming ideas and applying them to real-life settings to engage users. Students will interact with instructional materials in a playful and dynamic way thanks to the motivational psychology involved in game-based learning. Game-based learning is more than just making games for students to play; it's also about developing learning experiences that gradually incorporate concepts and lead users to a desired outcome. Competition, points, rewards, and feedback loops can all be incorporated into traditional games. Some people may believe that playing video games is bad and that it is almost always seen as an addiction, but it is impossible to ignore the benefits it provides to gamers [6]. Gaming aids in the development of imagination, decision-making, and perception. The advantages are numerous, ranging from enhanced hand-eye coordination in surgeons to improvements in vision that increase night driving performance.

### 1.2.4 Creating Role-Playing Games Based on Traditional Stories

A template for converting conventional stories into high school role-playing games and explored the process of creating games that suit the confines of secondary

classrooms and can be used to address specific educational expectations by developing three sample games focused on Greek mythology, Arthurian legends, and a popular folktale form [7]. The sample games were put to the test with groups of high school and college students, and the findings were analyzed in the form of a narrative case study.

The researchers came up with the idea of using the Philippines Myth instead of Greek mythology in the game's characters and quests.

#### 1.2.5 RPG in Mathematics

**Animo Math: The Role-Playing Game in Mathematical Learning for Children**, discussed that Math is one of the most fundamental skills that most parents want their children to be able to learn [8]. The mathematical game referred to as "Animo Math" has been created for children aged 5-7 years in order to enable them to pay more attention to mathematics. While playing this game, children can choose from a variety of cartoon animals to represent themselves. To draw children's interest, colorful cartoons and music are used. More significantly, the game is designed to cater to children of various ages and mathematical abilities, so artificial intelligence (AI) is used.

**Decimal Point: The Fantastically Fabulous World of Fractional Fun** that shows that a mathematics educational game can improve learning opportunities while also becoming more engaging [9]. In the study of 153 students from two middle schools, 70 students learned about decimals by playing an educational game called Decimal Point, while 83 students learned the same material through a more traditional, computer-based approach. On both an immediate ( $d = .43$ ) and delayed ( $d = .37$ ) posttest, the game resulted in significantly higher benefit scores in solving decimal problems, and it was scored as significantly more enjoyable ( $d = .95$ ). Students with no previous experience benefited the most from the game.

#### 1.2.6 Gameplay Design for Role-Playing Battle Systems

There are three types of gameplays available to players in role-playing games: narrative gameplay, which advances the game's plot, combat gameplay, in which the user confronts the game's obstacles, and exploration of the game environment, in which the user explores the in-game world [10]. Battles in role-playing games are distinct from those in other genres because they are based on the skills that have been created or chosen for the characters that the player is controlling. This means that fights in role-playing games have a pre-battle gameplay phase where the user maps out how their character will behave, as well as a battle gameplay phase. Furthermore, fights vary greatly from one role-

playing game to the next, but they almost always revolve around strategic decisions. The user must be strategic about both how they create their characters and how they use those characters in combat. The dynamics and the mechanics. The action role-playing game gameplay still relies heavily on strategic choices and the use of defensive, healing, and character-boosting mechanics. Although all of Scott Pilgrim's abilities are solely offensive, each new mechanic is a modification of the damage done to the game's enemies. The lack of number values and random values is the most influential game mechanic that explains why action-oriented games with role-playing game elements are not role-playing games. Since the user can perfectly avoid anything, the machine does, the user can kill any enemy in the game without taking any damage. In an action role-playing game like Final Fantasy 15, the enemy, and the user both have abilities that are guaranteed to strike, and the user can't escape taking damage.

#### 1.2.7 Game UI Prototyping with Unreal Engine 4

The Unreal Engine 4 will be used for the majority of the practical and interactive prototyping, with Slate and Unreal Motion Graphics in particular being used for graphical user interface implementations [11]. In addition, the engine offers quick and easy options for exporting a prototype. The Unreal Engine culture, as well as Epic Games' desire to provide information and technology to as many people as possible, may be driving forces behind this. The focus is on user interface design and the iterative prototyping process, both of which are extremely important to the author. The use of the Unreal Engine 4 as a user interface prototyping tool can be demonstrated by developing such a method in detail and testing it with the Unreal Engine 4 against some additional established parameters.

The article about the new PvP mode in Fortnite: Battle Royale and mentioned that during the development of the Battle Royale game mode, the developers made a number of performance, memory, and workflow improvements that will benefit not only Fortnite: Battle Royale, but all Unreal Engine 4 developers, particularly those working on games with similar requirements [12]. The Unreal 4 game engine has been used in several highly popular games (and franchises). Some of these are Fortnite, Octopus Traveler, Ark: Survival Evolved and Conan Exiles. These RPG games have an excellent gorgeous graphics, complete with bloom and stellar lighting effects [13].

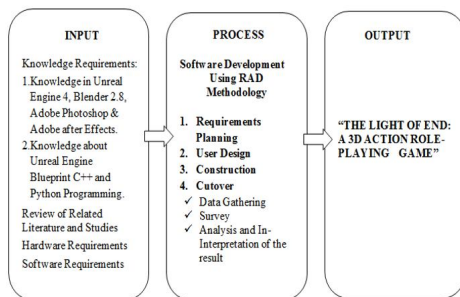
## 2. EXPERIMENTAL AND COMPUTATIONAL DETAILS

The study is aimed at all students and game enthusiasts playing RPG with 3d effects and Philippine myth

characters. During battle, the players can test how fast to add numbers in order not to lose. The game combines the best elements of a common genre, Action Role-Playing Games. In contrast to turn-based or menu-based fighting, this genre emphasizes real-time combat where the player has direct control over the characters. It comes with an addition problem that students or players can use to practice computing numbers. This allows them to enjoy learning as they study, especially one of the most important subjects, mathematics. The game also has a plot and narrative for a series of events, each of which influences the next level or chapter.

### Theoretical Framework

The researchers used the Input-Process-Output to summarize the procedure of the project development.



**Figure. 1.** Input-Process-Output (IPO) Diagram

In systems analysis, this is a commonly used method. The following is included in the IPO Diagram: Input, which is where the system's datasets are entered; Process, which depicts the input method used to create the game, in this case, the RAD Methodology; The created game "The Light of End: a 3D action role-playing game" is the final product.

## 2.1 DEVELOPMENT METHOD

The researchers used RAD methodology for the development of the game. When using the RAD methodology for game development, it is critical to seek the value of the client (software users) and convey the project's priorities and objectives, as well as any current issues that may be resolved during the build, to understand all project requirements.

The following steps were carefully followed and done.

### 2.1.1 Planning for Requirements

This often involves collecting the requisite information, such as conducting a survey and attending a project scoping meeting. The researchers began to plot out how they would make the game and the accompanying documentation and investigated how an inspiring storyline game can aid each player in improving solving simple mathematical computations. It also entails thinking about the map's layout, game mechanics, characters' personalities, and items that will be needed across the map, such as buildings,

trees, and grass. Both scenes will be addressed in relation to the plot and the process of coming up with solutions to specific game design problems. The ideas are created in stages, from a vague idea to a specific message with accompanying visuals and material. The definition describes the game's features, objectives, and overall gameplay. The game's plot was inspired by Philippine legends and myths, modernizing the framework and idea of legendary characters, firearms, species, and more. This game includes a function that displays the true specifics of each character as well as the weapons they wield in ancient times. This feature explains where they live and what role they played in that place. Part of this definition is to provide notes with the message "The plot of the game is just a fictional and derived from various Filipino myths." It does not apply to or reflect any of the Philippines' indigenous people." This message serves as a reminder that they do not say anything about myths; it is just a work of fiction used as a source of inspiration.

### 2.1.2 User Interface Design

Game design encompasses a wide range of disciplines, including programming, creative writing, and graphic design. The researcher starts the user design process by sketching out the characters', quests', and environment's potential characteristics and features. The following measures were completed after the conceptualization and drafting: (1) A manual drawing of the character and setting was created; (2) The drawing was scanned and transferred to Photoshop; (3) Blending, retouching, texture, and appropriate effects were added.

### 2.1.3 Construction

The researchers completed the following tasks during this phase: (1) used the Unreal Engine to program/code characters so that they could move, have skills, and obey commands. (1) the assets of the characters and the combat battle were carefully programmed to make each quest accessible; (3) the incorporation of math addition to gain the player's stamina during battle. The addition of numbers should be solved as quick as possible so that the player will regain strength during battle; (4) Beta testing of the game is also done to check for the possible bugs and errors.

### 2.1.4 Cutover

The game is published and created and now ready to be uploaded to itch.io. Itch.io is without a doubt the best forum for independent game development. Itch.io was designed to allow indie game developers complete control over their product page, including the ability to adjust the default publisher cut from 10% to 30% or 0%. The game can be advertised online in this way; all that is needed is for players to see and download it. The player will rate and comment on the game they played in the store and see what

the outcome of the review was so that the app can be changed or modified.

### 3. RESULTS AND DISCUSSION

#### 3.1 Designing Action Role-Playing Game with simple mathematical concepts

It's important to use tools that you can actually use to explore the various features that can be added to the game. Even though smartphones and tablets are the most widely used platforms today, they have less storage space than a computer and their components cannot be changed like those on a desktop computer. Because of their size, modules, and lower power requirements, desktop and laptop computers can run more powerful apps than smartphones and tablets. Blender is a free and open-source 3D modeling software. Modeling, rigging, animation, simulation, rendering, compositing, and motion tracking are all supported, as well as video editing and game production. To build new gameplay elements, Unreal Engine 4 offers two methods: C++ and Blueprint Visual Scripting. Programmers develop the base gameplay systems in C++, which designers can then build on or with to create custom gameplay for a level or game. The C++ programmer works in a text editor or an IDE, typically Microsoft Visual Studio, while the designer works in Unreal Engine 4's Blueprint Editor.

Photoshop, After Effects, and Premier are among the other programs used in game development. It has a significant effect on players since the user interface determines what they expect and reflects the game's theme. Game music is essential for mood and scene setting; to improve the game's feel, another program called Audacity is used to create music in all scenes. Music is often used in well-crafted games to assist and direct players through the game. For example, you can progress through various game levels or different areas of the map or game world. Music also aids in the player's comprehension of the plot and increased interaction with the game's characters.

For the integration of addition mathematical concepts, for the player to boost energy or regenerate, the player needs to answer a simple math problem as shown in figure below.



**Figure 2.** Math Question (Addition)

If the player stamina is low, he needs to solve mathematical computation to boost the energy, choices are provided. The

player must solve the equation as fast as he can to earn huge amount stamina booster.

#### 3.2 Graphics enhancement using Unreal Engine 4 and Blender 2.8

Epic Games' Unreal Engine (currently known as Unreal Engine 4) is a common and widely used game engine. It's used in a slew of modern AAA games, including Epic's own battle royale shooter Fortnite and Psyonix's Rocket League. It enables development on a variety of platforms, including PC and consoles like the PS4, Xbox One, and Nintendo Switch. Because of its ability to operate across channels, this is one of the reasons it is so commonly used. The researchers used this kind of technology to enhance the graphics of the game. The following capture images from the game used Unreal Engine 4 and Blender 2.8 for the support of 3d creation.



**Figure 3.** User Interface of the Main Menu

This is serves as the user interface of the main menu where players can choose from four options: new game, load game, settings and quit.



**Figure 4.** Play Game User Interface

This is the first scene of the first chapter of the game.



**Figure 5.** 3D creation of one of the characters using Blender 2.8



### 3.3 Significant Features of the Game

#### 3.3.1 Character Development

The characters were created on artifacts and history. It is based on the Philippines myths like IbongAdarna, AnitunTabo, Maria Makiling,Bathala and Sitan. They were created using 3d model software Blender 2.8.



**Figure 6.** Artifacts and History

Artifacts and History menu displays some facts and stories of the Myth the player have conquered.



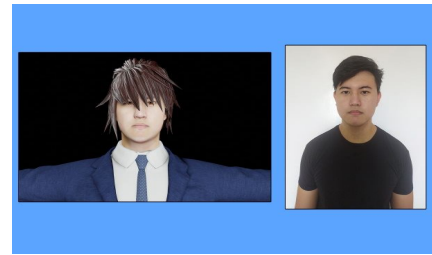
**Figure 7.** Maria Makiling

Maria Makiling is the guardian spirit of the mountain. Responsible for protecting its bounty and thus is also a benefactor for the townspeople who depend on the mountain's resources.



**Figure8.** Anitun Tabu

Anitun Tabu is the goddess of wind and rain. Ancient Tagalog often blame her for the occurrence of ambon and before the colonial period, it was even said that it was lucky to get married while raining, because Anitun Tabu is happy. It was originated in Zambales.

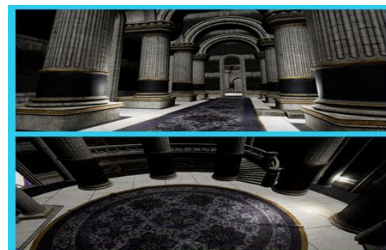


**Figure 9.** Face Builder

Actual face can be used for character development.

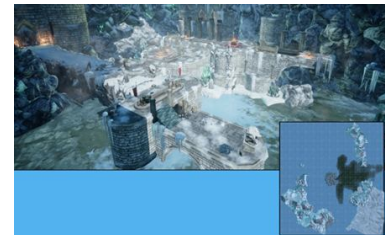
#### 3.3.2 Exploration / Adventure

This game is an open world where various quests can be selected like Forest, Caves, Castle and Ice Lands. Each quest contains different monsters and Boss.



**Figure10.** Castle

Kingdom of King Adonis and the place that Miguel, one of the player's character, serves.



**Figure 11.** Ice Land

The place where Miguel is bound to encounter Anitun Tabu.

#### 3.3.3 Strategy Combat

The outcome of the game will be determined by strategy rather than chance. This suggests that the game's outcome is heavily influenced by the players' decision-making abilities. If luck-based elements are overused, they may be unfair—one player can roll a string of high numbers while another rolls a string of low numbers, so victory may not be determined by how good the players were. If players have the freedom to choose their own acts, they will be more likely to win, and experienced players will have a much better experience.



**Figure 12.** Equipment

The player will decide which equipment to use to defeat the monsters and earned a victory.

### 3.3.4 Integration of Math Problems

Researchers created this action role-playing game with an educational component that focuses on mathematical computation problems and helps to immerse students in the game, which improves their computational skills.



**Figure13.** Math Question (Addition)

If the player energy or stamina is low, solving mathematical computation will help a lot to boost or regenerate energy.



**Figure14.** Correct Answer

If the player successfully answers the question, correct message will appear, and the stamina will be boosted.

### 3.3.5 Evaluation Result

The evaluation's respondents included 17 IT professionals, 54 IT students, 28 BulSU students, and 91 non-BulSU students. It also demonstrates the interpretation of the mean distributions, which varies from Bad, Fair, Good, Very Good, and Excellent as the highest interpretation. The researcher devised an assessment instrument based on the Software Quality Model following a five-point Likert scale.

The table shows the summary of the weighted mean for THE LIGHT OF END: 3D ACTION ROLE PLAYING GAME

**Table 1.** Summary of Weighted Mean

Criteria	Expert Response	
	Weighted Mean	Description
Environment	4.79	Excellent
Concentration	4.79	Excellent
Challenge	4.79	Excellent
Player Skills	4.76	Excellent
Control	4.78	Excellent
Clear Goals	4.76	Excellent
Feedback	4.76	Excellent
Immersion	4.69	Excellent
Overall weighted mean	4.76	Excellent

The data reveals that the game was rated “Excellent” in terms of Environment (4.79); Concentration (4.79); Challenge (4.79); Player Skills (4.76); Control (4.78); Clear Goals (4.76); Feedback (4.76); and Immersion (4.69). As a whole, the obtained mean value of 4.76 indicates that the proposed system was “Excellent” and was recommended for all users and players.

## 4.CONCLUSION

In summary, the study entitled “THE LIGHT OF END: A 3D ACTION ROLE-PLAYING GAME” created in Unreal Engine 4 showcased an excellent graphics and design that students and gamer enthusiasts will definitely enjoy. The characters like Maria Makiling, Anitun Tabu, IbongAdarna and Bathala were created based on the Philippine myths and Blender was used to apply image effects and texture. Combat battle in the game became much exciting by integrating addition math problems. The player must answer an addition math problem as quick as possible to regenerate stamina that will be needed to continue the game. Rad Methodology, which serves as a guide and steps in the development of the framework, was used by the researchers. The study got a computed total mean of 4.76 with an Excellence evaluation.

## 5. RECOMMENDATIONS

Recommendations could help broaden the scope of the study and perhaps given better clarity in particular areas and help in maintaining or upgrading the system functionalities. The following are possible improvements that recommended by the researchers.

1. Enhance the UI and the visual theme of the game.
2. Fine tuning in the graphics department and need some help with the aesthetics of the game, like how the inventory is presented, the borders of the frames used. It is also recommended to improve the conversation for every character in the game and how they interact to one another especially to the player.
3. Add status effect to inflict the target with the equipped weapon's status or magic. Add more skills during gameplay to improve cognitive abilities, such as increase visuospatial cognition, mental rotation, attention, and help individuals overcome cognitive limitations.
4. Add tutorials before starting the most gameplay to help a player navigate the controller and learn the mechanics and goal of a game.
5. HP potion is clickable for easy access if the player has low life and put some mark on the map so player can see where they go.

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