

Independent Project Proposal - Michal E Pfeiffer

by Michal Pfeiffer

Submission date: 20-Oct-2024 06:49PM (UTC+0100)

Submission ID: 240712689

File name: 40136_Michal_Pfeiffer_Independent_Project_Proposal_-_Michal_E_Pfeiffer_586419_703433281.docx (68.43K)

Word count: 1537

Character count: 8181



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Integrating the learning of mathematics into puzzle solving games

By Michal Emil Pfeiffer

BSC Computing (Game Development)

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Introduction

Within this project, it will try and achieve why the current education system needs more intuitive teaching methods by utilising games to help and aid students with their learning. The reason for such a project to be made is because not everyone fully understands and grasps mathematics, due to either personal reasons or medical reasons that does not allow them to learn mathematical concepts at their full potential, so this project wants to produce a game with good puzzle design that involves the use of mathematics to teach students in an easy to learn way that feels rewarding, to both the student and possibly the teacher based on feedback.

Aims & Objectives

Aim: Create a puzzle game with the purpose of teaching mathematics.

Objective 1:

The game should help the students that do play the game to master the most basic mathematical concepts of; Addition, Subtraction, Multiplication and Division, with room for other topics to also be introduced, like Indices. Once the student plays enough of the game and does regular math problems with success, the game is a success, and the student can use the basic knowledge to build-up more complex concepts.

Objective 2:

The UI (User Interface) must be user friendly so that the student can easily navigate through the menu and select what level they want to play so they can learn what they want to learn, and the settings so that user can customise the experience to their preference (like music, controls etc.).

Objective 3:

The game must be rewarding towards the student, through giving points or medals to the student based on their performance, be it; moves made, time of completion and/or method of completion. With the student being rewarded for completion of the level, it gives positive feedback enforcing better learning.

Objective 4:

The design of the puzzles must be both simple to understand at face value but also in-depth enough to build up confidence and teach the same concept at different difficulties. As if the game is too easy, the student won't learn as much or bolster their confidence in their skills. Likewise, if it is too complicated, the student will have a too hard of a time to learn and eventually learn nothing from it. Having the difficulty start easy to learn the

basic concept and then adapt to become more difficult with time will help the students learn.

Literature Review

The end goal of this entire project is to show that making learning be more of a game can help in understanding topics that otherwise some would find difficult, a study was made (source: [3]) that has done something similar with the focus on language learning, they have made a game based around command & conquer, where you have to occupy and conquer other territories by answering correctly on the questions provided.

Some challenging issues that can come from the project is the overall design of it, but mostly the puzzles themselves, if they are design poorly, the student themselves will either struggle or not get it at all, with many examples provided within source [2] of what makes a good or a bad puzzle level. Within source [1], it talks more about the general philosophy of the puzzle design in of itself, mentioning both linear and non-linear puzzles, where linear puzzles have only one possible solution whereas non-linear have multiple and more free flowing solutions that can range in efficiency.

There are also some game developers that have documented what they have done within the field designing and making puzzle games/levels, their documentations can be found in sources: [4], [5] and [6]. They mention methods of how a puzzle can be designed and which methods they chose to go with moving forward for their games respectively. The developer of the game "Taiji" has gone with two methods, being experimental and forward design method for their puzzles, with the experimental method being self-explanatory, with each puzzle being an experiment of what works and what does not, the forward method is more of how the puzzle is designed in terms of goal, where the goal at first is undefined until the concept you wish to introduce has already been met and the user understands it, with that being the first goal for the first puzzle, the subsequent puzzles can be more challenging and bolster the concept further.

Furthermore, in a report [7], it has been mentioned that only "5% of primary schools reached the Government's target of 90% of pupils reaching the expected standard in key stage 2 reading, writing and mathematics in 2019." [7]. Which in of itself is a statistic that this project is set to improve, mainly the mathematics side. As more and more children find schools monotone and/or boring with how they are being taught, the concepts and materials that are taught to them in class will not be maintained fully in their memory. The source [7] has a full report, that even mentions that the education system is funded on average, but each individual school seems to be on tighter budgets and not having enough staff in some areas.

Project Design

The development strategy that will be used throughout the project is **Agile Development Methodology**, as the pros outweigh the cons with the project at hand. Some of the pros include;

- Being adaptable to the situation at hand
- Able to test and design interchangeably at any given moment
- Greater focus on quality

The only glaring cons of using said method are;

- With a greater focus on the product, there will be less documentation
- Can take up more time than is allocated for a certain task

As the focus of the project is to make a game as the result, a greater focus will be needed on the quality of code to ensure that no bugs will be present to thwart the learning process and enjoyability of the said game, but as the focus will be made on code at hand, there will be lack of documentation of the coding process other than the result at the end of the process but there will be sufficient documentation of testing and designing of the said puzzles.

To define if the objectives are met for the project, qualitative and quantitative data must be collected to measure the effectiveness and quality of certain aspects of the game with a bigger focus on quantitative data. The data collected will be mainly used for rating the difficulty of puzzles, how much the student have learnt and the fluidity of the user interface. Whereas qualitative data would mainly be for any issues they had with the game and the designs of the puzzles and the user interface. The data itself would be best collected using a survey after a participant has played and tested the game whilst also keeping the anonymity of the participant. Another set of data that will be collected is the level of confidence of their mathematical skill before and after they have played the game.

The survey tool that would most likely be used is Office 365/Microsoft Forms, due to how easy it can be customised and set up for data collection from participants, whilst also providing useful tools like graphs to summarise data and be able to infer from to explain certain areas of the game. As a bonus, it can also provide anonymity of the person being surveyed, so that personal data that has been asked (which will only be the level of confidence in maths) will not be mishandled.

Resources

The resources needed for the completion of the project will be the game engine used for the creation and design process, with the two options being GODOT or Gamemaker for the game engine, due to these game engines delivering the right tools for the ideal game to be created, being a simple 2D puzzle solving game that has mathematics being the main problem and solution within the puzzles.

The other resource needed to justify certain designs made within the game would be the data collected from participants using a surveying tool, most likely being Office 365/Microsoft Forms due to how well known it is and the tools it provides being for easy understanding of the data that has been collected.

References

- [1]
J. Bycer, "The Philosophy of Puzzle Design," 24-Sep-2020. [Online]. Available: <https://www.gamedeveloper.com/design/the-philosophy-of-puzzle-design>. [Accessed: 18-Oct-2024]
- [2]
T. Hermans, "How to make a good puzzle - An explorable explanation," 29-Aug-2018. [Online]. Available: <https://www.gamedeveloper.com/design/how-to-make-a-good-puzzle---an-explorable-explanation>. [Accessed: 18-Oct-2024]
- [3]
S. Y. Cheung and K. Y. Ng, "Application of the Educational Game to Enhance Student Learning," vol. 6, Mar. 2021, doi: 10.3389/feduc.2021.623793. [Online]. Available: <https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2021.623793/full>. [Accessed: 18-Oct-2024]
- [4]
O. Mendel, "How I make puzzle games," 13-Jan-2023. [Online]. Available: <https://www.oskarmendel.me/p/creating-good-puzzle-games>. [Accessed: 18-Oct-2024]
- [5]
David, "How to create good puzzles - Board Game Analysis," 22-May-2024. [Online]. Available: <https://www.boardgameanalysis.com/how-to-create-good-puzzles/>. [Accessed: 18-Oct-2024]
- [6]
~ Matthew Vandevander, "84. How I Design Puzzles," 23-Feb-2022. [Online]. Available: <https://taiji-game.com/2022/02/23/84-how-i-design-puzzles/>. [Accessed: 18-Oct-2024]
- [7]

J. Andrews, "Education: the fundamentals - Eleven facts about the education system in England," 01-Dec-2023. [Online]. Available: <https://epi.org.uk/publications-and-research/education-the-fundamentals-eleven-facts-about-the-education-system-in-england/>. [Accessed: 19-Oct-2024]

Independent Project Proposal - Michal E Pfeiffer

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

74/100

PROJECT PROPOSAL – ACCA6020 INDEPENDENT PROJECT

Student Michal Emil Pfeiffer
Mark 74

Intro / A&O (400 words)		
Project title; Identification of a specific problem to be investigated; Well-defined aims and SMART objectives; Explaining why this project is worth doing; Discussion of what the project needs to do in order to be a success; Description any deliverables that will be produced at the end of the project	20	15
The student identifies the aim of research project to be the creation of a puzzle game, with the purpose of teaching basic mathematical operations(+/-/x/) at an elementary school level, with scope for more advanced and complex concepts. Four objectives are outlined as to what will constitute the successful outcome for the student ,		

but not all are SMART, particularly with regards to time constraints. A successful interactive game will be deemed a successful outcome. The student outlines his opinion as why such a project would stimulate interest in children who struggle with mathematical constructs due to personal or medical reasons as well as lack of intuition. The deliverable at the end of the project's time frame as well as its successful outcome is stated as a functional working and interactive game which the student/pupil can perform elementary mathematical tasks with.		
Background to the Project / Literature Review (400 words)		
Description of how the work to be done by in the project relates to the work identified in the literature review; Discussion of any ethical issues raised by the project Identifying what has already been done within the field; Topic familiarity; Brief literature review using appropriate sources – 6-8 journal papers and book chapters rather than just websites; Selection of relevant models & concepts	20	17

A literature review of current research in similar areas of pedagogy has been undertaken, particularly with to puzzle design and use in language teaching. Most articles are from online book sources as well as the occasional journal citation. Relevant comments on each publication are commented upon briefly in relation to the current project model, little or no discussion of possible ethical concerns of a puzzle game.		
Project Design (500 words)		
Clear statement of which development methods are to be used and why they are appropriate; Clear statement of which tools are to be used and why they are appropriate; Clear description of how data collected will be analysed. The project design and development strategy are outlined including the advantages and disadvantages of using the 'Agile development Methodology'. Both qualitative and quantitative data are to be collected and statistically analysed primarily from surveys and questionnaires measuring customer/student/pupil satisfaction with both game design speed, confidence and effectiveness etc. The data will be analysed and suitable inference deduced using	30	25

relevant Microsoft tools, to ascertain satisfaction with the end product.		
Resources / Planning (200 words)		
List of any deliverables; Clear diagram showing both timing and resource use; Completed ethics form; Limited and relevant appendices. Resources needed for the projects completion are briefly outlined namely 'GODOT OR GEMEMAKER' for the game engine. No deliverables are formally listed. However, a working and effective game aiding children with basic mathematical operations is deemed by the student to be a successful and deliverable outcome. No effective time line diagram or chart is produced to ensure the project work will be carried out in the allotted time scale. .	15	7

A detailed ethics form has also been completed along with this project proposal.		
Document Presentation		
Correct spelling, grammar and punctuation; Flow of narrative/fluency; Coherence; Word processed ; Correct use of referencing with bibliography; Strict word limit The project proposal does contain some spelling errors and some awkwardly written/expressed text, together with some non-academic language utilised in attempts to explain previous work, along with the project's aims in relation to what the student can expect from the game. The project proposal is word processed within the word limit and referencing is appropriate.	15	10
TOTAL	100	74

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