Universiti Teknologi MARA
Cawangan Melaka

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Progress in Computing and Mathematics Journal
College of Computing, Informatics, and Mathematics
Universiti Teknologi MARA Cawangan Melaka, Kampus Jasin
77300, Merlimau, Melaka Bandaraya Bersejarah

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EDITORS

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PREFACE

Welcome to the inaugural volume of the **Progress in Computing and Mathematics Journal (PCMJ)**, a publication proudly presented by the College of Computing, Informatics, and Mathematics at UiTM Cawangan Melaka.

This journal represents a significant step in our commitment to fostering a vibrant research culture, initially providing a crucial platform for our undergraduate students to showcase their intellectual curiosity, dedication to scholarly pursuit, and potential to contribute to the broader academic discourse in the fields of computing and mathematics. However, we envision PCMJ evolving into a beacon for researchers both nationally and internationally. We aspire to cultivate a space where groundbreaking research and innovative ideas converge, fostering collaboration and intellectual exchange among established scholars and emerging talents alike.

The manuscripts featured in this first volume, predominantly authored by our undergraduate students, are a testament to the hard work and dedication of these budding researchers, as well as the guidance and support provided by their faculty mentors. They cover a diverse range of topics, reflecting the breadth and depth of research interests within our college, and set the stage for the high-quality scholarship we aim to attract in future volumes.

As editors, we are honored to have played a role in bringing this journal to fruition. We extend our sincere gratitude to all the authors, reviewers, and members of the editorial board for their invaluable contributions. We also acknowledge the unwavering support of the college administration in making this initiative possible.

We hope that PCMJ will inspire future generations of students and researchers to embrace research and innovation, to push the boundaries of knowledge, and to make their mark on the world of computing and mathematics.

Editors
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MATHMINDSET: GAME-BASED LEARNING TO REDUCE MATH ANXIETY

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Abstract

Mathematics is one of the most important subjects for students to learn. Understanding topics, concepts, and formulas is crucial to fostering interest in learning it. The problem of anxiety in Mathematics arises when students fear dealing with it due to lack of confidence and interest, stemming from a lack of enjoyment in learning. To address this issue, a beneficial approach for students is through game-based learning. By implementing game-based learning as a platform for education, arithmetic topics can be learned easily without students realizing it. This project has three objectives: to design game-based learning that combines elements to foster interesting and enjoyable learning experiences, to develop game-based learning tools that can help students reduce anxiety related to mathematics, and to assess the effectiveness and enjoyment of game-based learning in reducing math anxiety among elementary school students. The GDLC methodology is utilized in the development of this project due to its suitability for saving time and ensuring a clear and simple development process. Upon completion of the project, results gathered from the 1st grade students of SK Merlimau 2, Merlimau, Melaka, based on a questionnaire using the EGameFlow model, revealed a 96.4% enjoyment rate. Additionally, questionnaires employing MSEAQ have also shown high scores. Thus, MathMindset: Game-Based Learning to Reduce Math Anxiety has successfully achieved all its objectives.

Keywords: Mathematics; Anxiety; Game-based learning; Enjoyment; GDLC methodology; EGameFlow model; MSEAQ

INTRODUCTION

Background of Study

Mathematics is known as one of the most important school learning subjects (Holmes et al., 2021). It's used at all levels of education and in various fields like finance and science. Tests like TIMSS and UPSR evaluate math skills, but there are concerns about students' performance, especially in Malaysia. Many students struggle with math, leading to anxiety and fear. These

individuals will try their best to avoid dealing with numbers (Kelly et al., 2022). MA does not require medical or psychiatric treatment (Cipora et al., 2022). Because of that, people, especially parents and teachers, play an essential role in helping children control their fears.

A study from Alanazi (2020) found that MA can occur as early as the age of 7 to 12 years, and this shows that the problem of MA needs to be emphasized from the beginning of childhood. Misconceptions and lack of understanding early on can worsen this fear. Peer guidance and innovative teaching methods can help, including game-based learning (GBL). GBL is effective in making learning enjoyable and improving comprehension, particularly for students with math anxiety. Games offer interactive and engaging learning experiences, especially through mobile technology. According to Homer, Raffaele, and Henderson (2020), GBL facilitates problem-solving, critical thinking, and comprehension of abstract mathematical concepts among students.

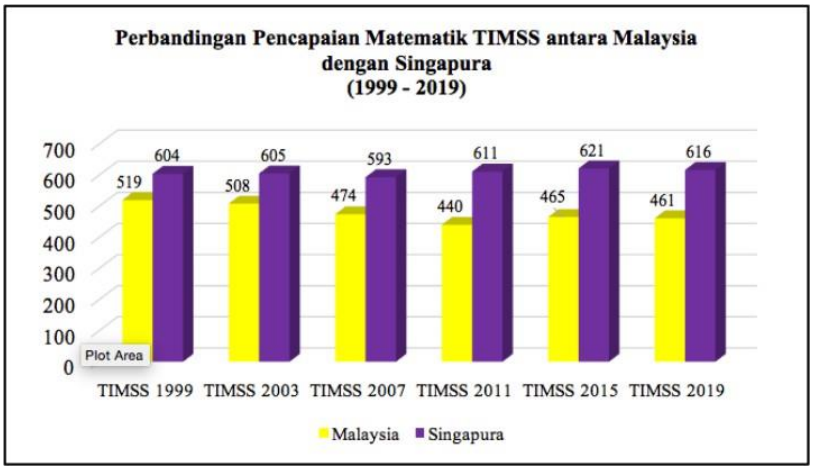

Figure 1: Comparison of TIMSS Mathematics Achievement between Malaysia and Singapore (1999-2019)
(Source: "TIMSS 2019: Bagaimana Pencapaian Matematik Malaysia Berbanding Singapura? | MajalahSains", 2021)

Problem Statement

a) Less effective to reduce math anxiety

According to psychological theories, math anxiety can arise from several factors such as issues in the curriculum, negative experiences with math, family and peer pressures, stress, teaching methods, and classroom settings (Alanazi, 2020) It negatively affects math comprehension and learning. When learning isn't enjoyable, students lose interest and motivation. Current teaching methods often

don't tackle math anxiety effectively, leading to negative attitudes. Bibliotherapy, suggested by Wilson (2009), uses reading and discussion to cope with emotions but may not fully reduce math anxiety.

b) Lack of enjoyment in learning mathematics

Alanazi (2020) suggests that fun is crucial for effective teaching. Teachers experiencing math anxiety tend to resort to traditional methods like lecturing, resulting in shallow teaching characterized by simple procedures and limited reasoning (Wilson, 2019). Consequently, students face repetitive tasks and heavy reliance on textbooks, which leads to disinterest and difficulty understanding mathematical concepts. Ling and Mahmud (2023) stress that uninspiring teaching strategies hinder student engagement and limit interaction in the classroom, impeding effective learning exchange. Barroso et al. (2021) note that individuals with math anxiety struggle to grasp math concepts, resulting in poor academic achievement. The lack of enjoyment in learning math presents a significant challenge to students' academic progress and their overall attitude toward the subject.

Objectives

There are several objectives that this project will focus on:

a) To design a game-based learning that combines elements to foster engaging and fun learning.
b) To develop game-based learning that can help students in reducing the problem of fear in mathematics.
c) To test the effectiveness and enjoyment of game-based learning to reduce math anxiety for primary school students.

Project Scope

"MathMindset: Game-Based Learning to Reduce Math Anxiety" is a game designed for primary school students who feel anxious about learning mathematics. The game aims to help students overcome math anxiety by engaging them with interactive math games. Vanbinst et al. (2020) found that students aged 7 to 8 struggles with arithmetic topics. Therefore, the game will focus on simple and interesting arithmetic topics like addition, subtraction,

multiplication, and division, targeting primary school students. Developing arithmetic skills can help children understand math fundamentals and build confidence in math (Balt et al., 2022).

The game includes multimedia components such as animations, graphics, text, audio, and video. It is created in a 2D environment specifically for desktop platforms. Using a 2D perspective is recommended for educational content like math and physics (Roedavan et al., 2021). The game will be in English, as it is adaptable and easy to learn.

Project Significance

Students:

The importance of this project lies in offering an enjoyable GBL experience in Mathematics, specifically targeting arithmetic topics, particularly for students who struggle with math anxiety. The incorporation of these games in the classroom has been shown to enhance students' attitudes toward math activities, potentially alleviating mathematical anxiety and fostering an enhanced learning atmosphere (Bouzid et al., 2021).

Teachers:

When students are motivated to learn Mathematics, it helps them grasp important topics better. This project focuses on creating games tailored for primary school students who feel anxious about Math. It also aims to support teachers and parents in improving their pupils' Math skills. By steering clear of textbooks and traditional classrooms, the project aims to offer a more enjoyable and engaging learning experience.

LITERATURE REVIEW

Math Anxiety

Math anxiety is the fear of dealing with numbers and calculations. It causes students to avoid math-related tasks, leading to academic worry and stress (Richardson et al., 2022; Tobias; Cipora et al., 2022). Research shows that math anxiety affects primary school students' performance and reduces interest in math class (Vanbinst et al., 2020; Ng et al., 2022; Mitchell & George, 2022). Difficulty understanding math concepts and formulas from the start can worsen math anxiety as topics become more challenging (Balt et al., 2022). Math anxiety isn't

a disease but a phobia, characterized by anxious responses to numbers and math problems (Cipora et al., 2022). Understanding its symptoms and causes is crucial for addressing math anxiety effectively.

Detecting Math Anxiety

The Abbreviated Math Anxiety Scale (AMAS) is a questionnaire used to evaluate math anxiety in children (Carey et al., 2017). Hopko et al. (2003) created the Math Anxiety Rating Scale (MARS), consisting of 98 items. Both AMAS and MARS assess feelings towards math-related tasks. They gauge the scale of math anxiety in children alongside their academic achievements.

The modified AMAS (mAMAS) is an adjusted version tailored for assessing mathematical ability (MA) in children (Carey et al., 2017). mAMAS questions focus on specific math topics like algebra or fractions. AMAS aims to summarize math anxiety issues students face and assess the factor structure's magnitude (Hopko et al., 2003).

Math Anxiety Symptoms

Math anxiety (MA) isn't a disease but shares characteristics with certain phobias (Cipora et al., 2022). It's a significant issue because many people aren't aware of its symptoms. Signs of MA, like sweating and avoiding math, can manifest in various ways (Kelly et al., 2022). MA can lead to feelings of helplessness and depression, affecting math learning (Mazana et al., 2018). Studies show MA can affect children as young as six, causing physical symptoms and discomfort in class (Weale & McLellan, 2019). Lack of confidence in math from an early age can lead to avoidance and poor performance (Espino et al., 2017). Symptoms of MA impact students' academic performance, as seen in studies like Barroso et al. (2021).

Math Anxiety Causes

Students experience math anxiety (MA) due to various factors, including facing mathematical calculations and numbers, which can make them feel uncomfortable, especially during learning sessions (Espino et al., 2017). A negative and unfriendly classroom environment can also contribute to MA (Bouzid et al., 2021), along with high-pressure situations, negatively impacting academic achievement (Espino et al., 2017).

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Additionally, lack of confidence increases MA as students fear embarrassment from wrong answers, affecting mathematical achievement due to negative feelings and stress (Caviola et al., 2017). Gender differences contribute to MA, with studies showing higher levels in girls compared to boys (Vos et al., 2023). Environmental factors and genetic susceptibility also influence MA, with genetic factors accounting for 40% of variations (Balt et al., 2022).

Game-Based Learning

Game-Based Learning (GBL) blends play and education to make learning enjoyable for students (Shi & Shih, 2015). Developed with a fun concept, GBL attracts students to education and indirectly helps reduce Math Anxiety (MA) issues (Link et al., 2009). GBL incorporates game components like guidelines, obstacles, competition, and rewards, allowing students to learn while playing the game "MathMindset: Game-Based Learning to Reduce Math Anxiety."

GBL encompasses both digital and non-digital games, while Digital Game-Based Learning (DGBL) specifically focuses on digital games as a learning platform (Anastasiadis et al., 2018). Learning through DGBL enhances academic performance, particularly in STEM subjects (Wang et al., 2022).

Various delivery methods in learning, including GBL and DGBL, address educational challenges and increase student engagement (Falciani, 2020). GBL serves as an educational tool to enhance student learning levels and encourage active participation in the learning process (Anastasiadis et al., 2018).

METHODOLOGY

Phases of Methodology

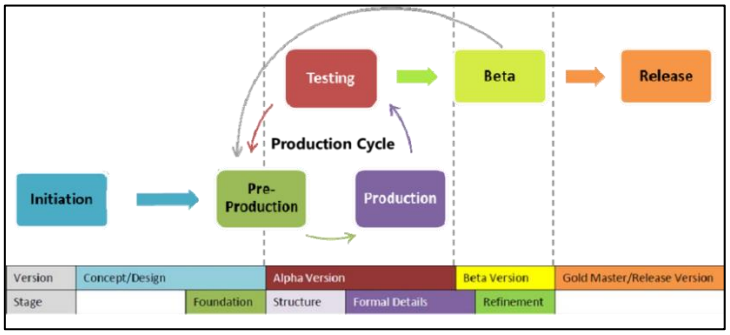

Figure 2: Actual game development life cycle process
(Source: Refnaldi, 2023)

Initiation Phase

The initial phase of game development is crucial and involves gathering information from reliable sources like books, websites, and databases (Refnaldi, 2023). This information helps define key elements such as the background, problem statement, objectives, project scopes, and significance, setting the foundation for the project's further development stages.

Pre-production Phase

Pre-production is the process of creating game designs, refining ideas and documentation for game designs, and creating game prototypes (Refnaldi, 2023). Pre-production is the earliest phase that serves as the basis for game design. It includes developing game prototypes to incorporate fun elements, layouts, and animations that align with the game's objectives.

Production Phase

During the production phase, assets like graphics and sounds are created, and source code is developed using Unity software and the C# programming language (Ramadan & Widyani, 2013). This phase integrates all elements such as animations, environment design, audio, and background music to build the complete game.

Testing Phase (Functionality Testing)

Testing, also known as alpha testing, is the phase of testing the developed game. This phase is very important because it will try and demonstrate the project's success (Singh, 2023). Testing is a process to see if the output is the same or not as planned.

Beta Testing Phase (Enjoyment)

Beta testing ensures the game functions smoothly and meets the intended goals (Patel et al., 2017). After alpha testing, which examines fully featured games, beta testing gathers feedback on the game's performance. Using 'Gamefulquest' questions, Grade 1 students at SK Merlimau 2, Merlimau, Melaka will provide feedback on visual enjoyment and whether the game reduces math anxiety. Each student will spend one hour using the game, and their feedback will guide improvements or the game's release. Bugs and errors identified during beta testing will be addressed before the game's final release.

Release Phase

The final phase in the GDLC is the release phase, signifying the project's readiness for distribution. The release is the last process before the game is officially released when it passes beta testing (Refnaldi, 2023). After that, this game can be distributed to targeted users, primarily school students with anxiety problems in mathematics. The chosen platform for this game is desktop-based, as desktop computers are commonly utilized in primary school computer labs. The desktop based game makes it easier for teachers to use these game applications as an educational tool for students.

TESTING AND EVALUATION

Enjoyment Evaluation

User feedback plays an important role in evaluating whether a video game meets the objectives of the project, especially regarding fun. The EGameFlow questionnaire served as a guideline to assess the enjoyment experienced by all players involved in this project, especially primary school students aged 7 to 8 years. This questionnaire assesses various factors of enjoyment, including challenge, accomplishment, and knowledge improvement.

Challenge

Out of 41 respondents, 39 (95.12%) found the challenges positive and not burdensome. Players need to earn at least 1 star to advance to the next level, a feature appreciated by 38 (92.7%) respondents. Only 4 (9.8%) respondents disagreed that the game motivated them to improve. However, 40 (97.6%) respondents found the instructions helpful in facing challenges, with hints provided in the early levels to spark interest in Mathematics. Additionally, 40 (97.6%) respondents appreciated the game's pacing of presenting new challenges. The overall mean score from the questionnaire is 4.50.

Accomplishment

Out of 41 respondents, 37 (90.24%) agreed that achieving goals in the game boosts enthusiasm. Players earn stars based on correct answers. Only 2 (4.88%) respondents disagreed that the game motivates performance standards. Additionally, 40 (97.56%) respondents expressed motivation to advance levels and pursue goals. However, 3 (7.32%) respondents

disagreed with the motivation to progress. The total mean score for this factor is 4.49, slightly different from the challenge factor.

Knowledge Improvement

Out of 41 respondents, 39 (95.12%) agreed that the game enhances their knowledge, which is crucial for primary school students learning Mathematics. Additionally, 39 (95.12%) respondents applied the basic ideas taught in the game. However, 3 (7.32%) respondents disagreed that the game motivates them to integrate the knowledge. Overall, 38 (92.68%) respondents attempted to apply their knowledge in the game. The total mean score for the knowledge improvement factor is 4.51, the highest among the three factors.

Math Anxiety Evaluation

The second questionnaire assesses Math Anxiety (MA) using the MSEAQ to gauge if the game effectively decreases students' MA levels.

Pre-Intervention Decisions to Reduce Math Anxiety

Before engaging with MathMindset: Game-Based Learning to Reduce Math Anxiety, students' pre-intervention results showed negative perspectives on Mathematics, with most responding "strongly disagree" to questions about their experiences. However, two questions about feeling stressed in math class and during math homework received "strongly agree" responses from some students.

Post-Intervention Decisions to Reduce Math Anxiety

Post-intervention results from MathMindset: Game-Based Learning to Reduce Math Anxiety

show a positive improvement in students' perspective on Mathematics. Many students responded with "strongly agree," indicating that the game helped alleviate their math anxiety by making learning enjoyable.

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CONCLUSION AND RECOMMENDATION

Project Conclusion

Mathematics can be challenging for students, leading to math anxiety. To address this, MathMindset: Game-Based Learning aims to make math more enjoyable for 7 to 8-year-old students. Using tools like Adobe Illustrator and Unity, the project tests the effectiveness of game-based learning in reducing math anxiety. Evaluation includes EGameFlow to measure engagement and the MSEAQ instrument for anxiety levels. Feedback from students at SK Merlimau 2, Melaka, confirms that the game enhances enjoyment and achieves its objectives effectively.

Project Limitations

Although the project achieved its goals, there are areas for improvement to enhance the game's appeal:

a) The game focuses on a narrow range of Math topics and lacks variety in questions due to time constraints during development.
b) Accessibility is limited as the game can only be played on desktops and isn't available on mobile devices or Macs due to the complexity of cross-platform compatibility.
c) The game doesn't offer automatic star rewards due to technical and logistical challenges, including the design complexities of creating fair assessment systems.

Project Recommendations

Suggestions for improvement include:

a) Including a broader range of Mathematics questions and topics to encourage deeper exploration by students.
b) Expanding Math Explorer games to be playable on multiple platforms, such as mobile devices and Mac, instead of just desktops.
c) Introducing automatic star rewards to allow players to engage with the game independently, eliminating the need for manual ratings from guardians or teachers.

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