

Exploration Gamification of Trigonometric Equations in High School Students within the Joyful Learning Framework

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Abstract

Trigonometric Equations are often viewed as a daunting prospect for high school students because they demand mathematical creativity and the discipline of memorizing rigid procedural formulas, thus triggering emotional unpreparedness at the beginning of learning. This study aims to explore in-depth the flow of students' emotions through the implementation of interactive gamification-based learning media entitled "Misi Penyelamatan Planet Alpha". Using a qualitative descriptive approach within the Joyful Learning framework, this research observed the behavior, interactions, and affective responses of 34 students of grade XI-2 SMAN 6 Kota Malang for the 2025/2026 academic year. Data were collected through direct observation by peer observers, distribution of questionnaires on the implementation of gamification, and in-depth interviews validated through data triangulation. The results show a dramatic shift in students' emotional paradigm, a classroom atmosphere that was initially sluggish and passive successfully turning into an addictive, interactive, and cheerful arena of competition. The integration of trigonometric equations into the narrative of a secret-agent science fiction story successfully changes students' perceptions of mathematical formulas from a burden of memorization into an urgent key code or instrument for solving contextual problems. Furthermore, three main triggers of students' intrinsic happiness were found: dramatic narrative responses on the Canva AI platform, the effect of tension from mission success, and the development of learning resilience through intensive group discussions when confronting calculation errors. This study proves that placing students' happiness and emotional engagement as the top priority is able to produce reasoning processes that are mathematical and meaningful without any element of coercion for students.

Keyword: gamification, trigonometric equations, joyful learning

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Introduction

Technological progress is something that cannot be avoided in this life; technological progress moves in line with advances in science. Every innovation is created to provide positive benefits for human life. Technology also offers conveniences, as well as a new way to carry out human activities. People have also enjoyed many benefits brought by technology innovations that have been produced in the last decade. In this modern era, the development of technology and information has grown rapidly and its influence on the

world of education can no longer be avoided—whether it is a positive influence or a negative one—thus requiring the education sector to continuously adapt to technological developments in efforts to improve the quality of education, especially in terms of utilizing technology and information for education, particularly in the teaching and learning process.

Instructional media have begun to develop rapidly, especially technology-based instructional media. Various instructional media are starting to be packaged in modern and unique ways, both in the form of hardware such as pocket books, student worksheets, or software such as Android Studio and applications for computers and mobile phones packaged in an interactive form. Learning media are tools used to convey information from teachers to students (Mayangsari, 2025). An enjoyable learning process requires learning media that attract students' interest to learn and connect their prior knowledge to new contextual knowledge, such as problems in daily life experienced by students. According to Dewi et al. (2024), interactive media has the potential to improve the quality of learning and can stimulate students' interest in learning because of its attractive appearance. Learning media is one of the innovations in learning that can be used by teachers to increase students' interest in learning and the learning outcomes themselves.

Indonesia ranks second highest in video games when compared to countries in Southeast Asia. According to Karnilah et al. (2024), Indonesia is named the most active gamer in the world. This can be interpreted that a large portion of Indonesian citizens are active in playing games. The phenomenon of increasing video game users is expected to spill over into various aspects of life, including education. Many learning platforms have successfully presented gamification concepts to increase interest and learning outcomes in mathematics. Game-based technology mathematics learning has several advantages, including making the learning process more enjoyable, helping students to focus and pay attention to learning activities, and it can also give students opportunities to compete and explore.

Gamification is an approach to learning that utilizes game elements in teaching and learning (Irnawati et al., 2024). In gamification, students will get scores, points, levels, rewards, and challenges like in games. This can motivate students to learn mathematics with more enthusiasm and zeal. Gamification in learning becomes an interesting research topic because several studies have shown its effectiveness in increasing motivation and reducing excessive anxiety toward a subject. However, further research is needed to systematically test the influence of game-based learning on increasing motivation when learning mathematics. Therefore, there is a need to develop modern learning media in the form of software on devices used by students anytime and anywhere. One factor that increases students' motivation is the emergence of interactions between teachers and students that are engaging to improve the quality of learning outcomes in mathematics. Games become an interesting place for students to learn many things in a fun way.

Relevance of using learning media in the form of gamification on the material of this trigonometry equation is so that students feel that learning mathematics is enjoyable and full of challenges. Students will consciously follow the game flow to complete the mission to rescue the planet Alpha, which contains trigonometric equation material. The Joyful Learning approach prioritizes happiness and emotional engagement of students in the learning process (Girsang & Rahayu, 2025). Deep learning not only aims to improve academic ability but also to shape character, creativity, and empathy, so students grow into a whole and globally aligned individual (Ministry, 2025). In mathematics learning, the application of game design elements increases user engagement, productivity, and cooperation among students in completing the mission together.

Method

This study is a qualitative descriptive study that will describe explorations of gamification conducted by students toward classroom learning, showing that the learning experienced by students is enjoyable. This study was conducted in class XI-2 of SMAN 6 Kota Malang in the academic year 2025/2026 with the material "Trigonometric Equations". Qualitative data analysis is a systematic process to understand, interpret, and give meaning to data obtained from interviews, observations, and documents. The purpose of data analysis is to find patterns, themes, and categories that emerge from the data, thus able to answer the formulated problem. The subjects in the study are XI-2 students, totaling 34 learners at SMAN 6 Malang. Data collection techniques include observation, distribution of questionnaires, and interviews. Several instruments used include: gamification implementation questionnaire, observation sheets, and draft interview questions to determine the emotional flow of students when carrying out gamification in mathematics learning. In the observation activity, the observer is a mathematics teacher who does not teach in the class, to determine the emotional flow shown by students to frame joyful learning in the learning day. The collected data can be viewed again through the recording of teacher and student activities that support the findings in this study. The results of the questionnaire data are given a score, then analyzed with the results of observation and triangulated data through interviews with students.

Result and Discussion

Implementation of interactive gamification learning media "Planet Alpha Rescue Mission" within the joyful learning framework was carried out on September 16, 2025, in class XI-2 SMAN 6 Kota Malang. This interactive gamification integrates trigonometry material learned by students in the Advanced Mathematics subject. At the beginning of the lesson, the teacher wrote "Trigonometric Equations" on the board. The responses given by students were mostly complaints reflecting emotional unpreparedness and disinterest in learning, such as "oh, not again", "trigonometry again", "more practice problems," and others. Students' body gestures also reflected unpreparedness to learn, such as leaning on the chair, resting the chin, and staring out the window with an empty gaze.

This is because the trigonometry material is considered to require creativity and patience from students. However, after the teacher stated that the day's learning would use an interactive game, the classroom atmosphere became more enthusiastic. This can be seen from the change in students' seating positions, and eyes focused on the LCD in front. At the beginning of the lesson, when the teacher conveyed that the material to be studied was Trigonometric Equations, some students showed tense expressions and lacked enthusiasm. However, with the gamification "Planet Alpha Rescue Mission," when the teacher narrated about a secret agent, a process of collaboration within groups and healthy competition between groups emerged. Students lasted longer in solving problems because they felt they were not learning but playing.

During the process of teaching trigonometric equations with gamification, many student responses showed that joyful learning has emerged in the learning. Students demonstrate active engagement through group discussions, mutually provide solution ideas, as well as mutually help to understand mission clues. Students are also enthusiastic to level up next, and a sense of curiosity about the missions – the missions present in the gamification. This makes the classroom atmosphere livelier because students not only focus on the final answer but also enjoy the process of solving the problem in each challenge given in the game.

The implementation of this learning starts with the teacher ensuring all students use devices or laptops connected to the internet and with sufficient battery. Students are also asked to prepare writing tools to help complete the missions that will be completed in the

given game. After everything is prepared, the teacher shares a web link containing the interactive gamification “Mission to Save Planet Alpha.” Students are asked to press the start button on their device screens. After that, students will begin the learning experience through the missions provided by the game. By following the instructions, students must complete the missions within the given deadlines. The mission storyline is also used to attract students’ attention to learn trigonometric equations. According to Dewi et al. (2024), interactive media such as this gamification can increase students’ understanding of the entire sequence of mathematics learning processes in the classroom. Educational innovation can improve teaching quality supported by interactive media, and help students in understanding concepts, academic achievement, and critical thinking skills.

Table 1. Student Emotional Flow in the Joyful Learning Framework

Activity	Estimation Time	Activity Domain Student	Indicator Emotion	Analysis of Joyful Learning
Orientation about gamification	Minute to 0 - 15	The teacher mentions the topic "Trigonometric Equation". Student prepares receiving the material.	Anxious, tense, passive, bored	Showing the presence of students’ initial emotion located in the negative zone due to rigid formulas. Curiosity shattering anxiety. Fear was replaced by interest in visual aesthetic elements and game narrative.
Introduction Mission	Minute to 16 - 25	The teacher shares gamification links to Canva AI. Student reading narrative "Misi Penyelamatan Planet".	Curious, confused, but interested	The formula changes become the rhythm of games. Counting not again coercion, but as a tool (key) that is needed to complete the desire to play. Emotional satisfaction triggered release dopamine that locks concept understanding permanently without memorization.
Exploration & Competition	Minute to 26 - 60	Student into group solve equation trigonometry for opening the “code key” level the next.	Enthusiasm, challenging, interactive.	Learning is closed with positive emotions that are stable. Students no longer look at mathematics as
Mission Peak	Minute to 61 - 70	The group successfully completed the mission end (for example, directing the rocket with angle trigonometry that precisely).	Satisfied, proud, happy.	
Reflection	Minute to 71 - 90	Students fill in reflection sheets and writing impressions lesson day that.	Relax, addiction, appreciative.	

Trigonometric equations are not only practice problems but are tightly integrated with the secret agent storyline, providing a strong context and increasing the material's relevance for students. By presenting trigonometric equations in the context of an urgent mission, students are required to think critically in applying the concepts they have learned. They must identify the type of equation they face, choose the appropriate solving method (e.g., using trigonometric identities, graphs, or a calculator), and find solutions relevant to the scenario. The secret agent scenario offers an engaging and challenging setting. When students must solve trigonometric equations to "unlock the key," "shoot the rocket," or "aim the signal," they no longer feel they are doing ordinary math problems. This planet-saving mission is said to be completed when students are able to solve all challenges. The activity of completing this mission attracts students to support learning activities.

Based on the above description, the implementation of gamification learning can transform the classroom atmosphere from initially unenthusiastic to full of challenges. Students discuss and debate with the classmates next to them in solving challenges step by step. Emotionally, some usually passive students start to dare to express opinions and try to answer challenges, even though they are not fully confident of their answers. This shows that the innovative learning in the form of gamification can help change students' psychology from being afraid or finding it hard to learn the material to being interested to learn more. Many conversations among students describe their enthusiasm, such as "eh, don't use sin directly, change the cos first," "this uses π , change it first," and others. Students' expressions are no longer dull with blank stares but become more lively and cheerful. This aligns with Gersang and Rahayu (2025), who state that the joyful learning approach must prioritize the happiness and emotional engagement of students. This change in emotional flow shows that gamification can transform students' perceptions, who were initially tense and afraid, into being challenged and happy to carry out the learning process. Some responses visible in students include crowding together, being noisy in groups for discussion, occasionally shouting with enthusiasm, laughing, clapping, and showing a proud response when completing a mission.

The application of gamification brings a different classroom dynamic from conventional mathematics learning. Teachers are no longer the center of learning, but students strive to discover the learning objectives by constructing their knowledge with their peers. The missions in the game that involve rescue missions challenge students more to solve problems. Based on the results of implementing interactive gamification learning media "Mission to Save Planet Alpha" and analysis of students' responses during learning, there are specific factors that trigger students' happiness and emotions, namely immediate mission-based feedback. This section triggers students' happiness for several reasons based on interviews with students:

1. AHA Moment

When students enter the solution of a trigonometry equation into the digital canvas column, the system will provide a dramatic response. The response makes students display behaviors such as smiling and laughing aloud when they successfully solve the challenge. They also shout and respond to each other in the classroom like "Yay", "Hooray...", "Am I smart?" The emotional connection of students with this material significantly enhances their ability to understand and remember concepts (Mayangsari, 2025). This also aligns with indicators of positive emotional engagement in joyful learning that prioritize students' happiness and intrinsic motivation in learning.

2. Life-and-death tension effect

Transforming abstract math problems into a challenge in this gamification triggers students' emotional attachment. Students feel they have full control over the course of the game. Unconsciously, students actively doodle in their notebooks, compute special angle values, analyze quadrants, and test trigonometric identities to solve the challenges. From this phenomenon, it is shown that integrating games into the learning process makes students more focused (Irnawati et al., 2024). This also aligns with indicators of challenging excitement in the joyful learning approach.

3. Building learning resilience

This direct feedback also stimulates students' fighting spirit. When students realize their answer is wrong while solving a challenge, they do not get frustrated but rush back to check possible calculation errors. Intense debates are also visible as students try to complete the challenge. This attitude of not giving up proves that the implemented gamification successfully changes the perception of learning mathematics from a burdensome activity to an addictive, enjoyable, and meaningful challenge. This also demonstrates one of the indicators of joyful learning, namely social collaborative learning.

Conclusion

Based on the data analysis results and discussion on exploring mathematics learning in class XI-2 of SMA Negeri 6 Kota Malang, it can be concluded that the implementation of interactive gamification media "Mission to Save Planet Alpha" based on Canva AI proves effective in reversing students' negative emotional curve from anxious, tense, and passive zones to positive emotional zones that are enthusiastic, joyful, and appreciative. The integration of trigonometric equation material into the fictional sci-fi agent storyline can change students' perceptions of mathematics, which was previously seen as a rigid procedural memorization burden, into a contextual instrument or 'answer key' that is meaningful for solving challenges. The direct feedback mechanism behind this mission bet that this wager has successfully spurred the formation of healthy competition, increased focus, sparked interactive group discussions, and built students' learning resilience, reflected in a refusal-to-fail attitude when facing miscalculations. Through the Joyful Learning approach that prioritizes emotional engagement and intrinsic happiness of students, the process of mathematical reasoning can finally grow organically in the classroom without any coercive elements.

To optimize the utilization and sustainability of this research, several recommendations can be given to educational stakeholders. For mathematics teachers, it is hoped that they can consistently explore and utilize other digital technology platforms to design gamification-based learning media for other abstract materials that have high mathematical anxiety among students. For researchers, it is advised to conduct further quantitative experimental research or use mixed methods to statistically test the effectiveness level of this Joyful Gamification model on improving academic learning outcomes, critical thinking abilities, and long-term memory retention of students on a broader scale. Exploration can be developed by continuously seeking the latest technology innovations that can support gamification, such as augmented reality (AR) and virtual reality (VR), so that students gain a more interactive and engaging learning experience.

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