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Developing students' motive achievement through Torrance's concept in conjunction with gamification

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Abstract

Background: Motive achievement plays a crucial role in students' academic success and personal development. To enhance this, the study integrates Torrance's future problem-solving framework with gamification strategies.
Aim: This classroom action research aims to improve the motive achievement of 11th-grade students by implementing structured, problem-solving-oriented learning activities that foster motivation and engagement.
Method: The study involved 20 Grade 11 students and utilized lesson plans incorporating Torrance's framework and gamification. Data was collected through motive achievement tests, observations, and interviews, and analyzed using means, percentages, and standard deviations over three cycles.
Results: The findings demonstrated a steady increase in the percentage of students meeting the success criteria: 25% in cycle 1, 55% in cycle 2, and 75% in cycle 3. This indicates a significant improvement in motive achievement through the integration of Torrance's concept and gamification.
Conclusion: The study concludes that this innovative approach effectively enhances motive achievement and can be a valuable instructional strategy in science classrooms. Future research could explore its application in other subjects or educational levels to validate and extend its impact.

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INTRODUCTION

The landscape of education in the 21st century demands a more robust and grounded approach compared to previous centuries. Advanced thinking skills, commonly referred to as 21st-century skills, such as critical thinking, creativity, collaboration, and communication, have become essential competencies that individuals must develop throughout their lives to effectively navigate daily challenges (Janpleng & Ruangmontri, 2021; Prachagool & Nuangchalerm, 2021). These skills are not only important for personal and professional growth but also serve as foundational abilities that allow individuals to adapt and succeed in a rapidly changing world. Additionally, the role of science in modern society underscores the importance of these skills, as science is deeply embedded in both work and learning processes (Johansson & Vinthagen, 2019). Thus, education must equip students with the intellectual capacity to thrive in various fields of life.

However, the unprecedented impact of the COVID-19 pandemic has disrupted the educational system, further emphasizing the need for these skills. With schools transitioning to online learning for nearly two years, the effectiveness of education was compromised. Although virtual learning environments provided a temporary solution, they could not fully replicate the engagement and effectiveness of traditional classroom instruction (Wang & Lin, 2021; Haleem et al., 2022). This shift also deepened educational inequality, as not all students had equal access to technology and supportive learning environments. As a result, many students experienced learning loss and disengagement. Furthermore, upon returning to school, issues such as tardiness and absenteeism persisted, revealing a significant lack of motivation among students, a factor critical to academic

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success, particularly during adolescence (Wang et al., 2020; Patrick & Kaplan, 2022). This highlights the urgent need to explore new strategies that not only address learning loss but also rekindle student motivation.

To address these emerging educational challenges, Torrance's future problem-solving instructional model provides a promising framework for enhancing student engagement and cognitive development. By encouraging students to anticipate and respond to future challenges, this model fosters critical thinking, analysis, synthesis, and evaluation skills (Juhji & Nuangchalerm, 2020). Moreover, this approach helps students move beyond immediate content and develop strategies for solving complex, real-world problems. In combination with gamification, which integrates game elements such as rewards and challenges into learning, the potential for increasing student motivation and engagement is further amplified (Sailer & Homner, 2020; Kalogiannakis et al., 2021). Together, these methods create an innovative educational model that not only addresses the motivational deficits exacerbated by the pandemic but also strengthens problem-solving abilities. This study aims to explore how the integration of Torrance's problem-solving model with gamification can enhance both the motivation and achievement of 11th-grade biology students, particularly in learning about the circulatory and lymphatic systems.

Building on the understanding that gamification can improve motivation and engagement, combining this approach with Torrance's concept of future problem-solving offers a creative solution to educational challenges. Using creative strategies, as introduced by Torrance, is crucial for helping students develop problem-solving skills, particularly in challenging subjects like the circulatory and lymphatic systems. This method allows educators to identify specific difficulties students face in grasping these topics (Hertel & Wicmandy, 2021; Wang, 2021). Understanding these challenges is key to creating tailored learning plans that address students' needs effectively. Moreover, this approach makes it easier to differentiate between simple mistakes in procedures and deeper misunderstandings of concepts, enabling more targeted teaching interventions (Duangrawa & Nuangchalerm, 2020). In the context of biology, where both abstract thinking and practical application are required, combining gamification with creative problem-solving presents an innovative way to address the gaps currently seen in biology education.

Gamification has proven to be a powerful tool for increasing motivation in learning environments by incorporating game-like elements. A meta-analysis by Puspitasari (2023) highlights its ability to boost student participation and motivation, leading to better learning outcomes. Similarly, Dirgantoro et al. (2022) found that its success depends on whether students are driven by internal or external motivation. However, studies by Mekler et al. (2017) and Ede (2022) point out that gamification often works as an external motivator, which has limited influence on internal motivation. Kim and Castelli's (2021) meta-analysis confirms that gamification improves student motivation and engagement, but most studies have not explored its integration with Torrance's future problem-solving concept. While gamification is widely used to encourage student motivation (Valentinna et al., 2024), there is still a lack of research exploring how the combination of gamification and Torrance's future problem-solving concept can improve students' motivation and achievement in biology learning. To fill this gap, this study introduces a new approach that not only motivates students but also significantly enhances their problem-solving abilities.

METHOD

Research Design

This study employed an action research approach to investigate how the integration of Torrance's future problem-solving instructional model with gamification can enhance the motivation and problem-solving abilities of 11th-grade biology students. Action research was chosen because it

is a reflective process of progressive problem solving, conducted in cycles, which allows for iterative testing and improvement of teaching strategies. The study was carried out over three cycles, each involving a sequence of planning, acting, observing, and reflecting. The details of methodology can be expalied as following.

Participants

A total of 32 students were tested with scores below 70 percent of the total score as the target group. Twenty students in Grade 11th, Semester 2 of Academic Year 2022 at one school in Kalasin province, Thailand were participated in this study. The researchers used a motive achievement test to measure their score and level of motive achievement before implementing the instructional method.

Research Instruments

1. Torrance's concept of solving future problems in conjunction with gamification uses two concepts: The process of solving future problems according to Torrance's concept is a systematic problem-solving process that begins with recognizing situations that are currently problems that have not yet arisen and applying knowledge and understanding from experiences and rules to the process of solving future problems according to Torrance's concept in order to obtain the best solution to future problems. Gamification is the use of techniques in the form of games without using the game itself. It simulates the environment as a game to stimulate and motivate learners to learn. Engage learners in learning in a fun way. Uncomplicated actions cause learners to behave (Table 1).

Table 1. Lesson plan

Syntax	Explanation
Bringing future circumstances into thinking systems	Present future situations that have not yet occurred or encourage learners to think fluently. Flexible thinking, initiative, and imagination to predict future conditions based on one's own data, facts, and experiences.
Brainstorming to find problems	Participants brainstorm to find problems from case studies that require them to analyze what problems may arise in the future. Students will provide their ideas and opinions with peers.
Summarizing the problem and Gamification	Summarize the brainstorming problems and prioritize them, students group the analyzed problems or arrange relationships to determine what is the primary problem, what is the secondary problem, and prioritize the problem. If a student selects a problem in accordance with the process skills assessment criteria at this stage, 1 point will be awarded.
Brainstorming solutions	Brainstorm to come up with the main solution, allowing students to jointly find the most important problem from the previous stage by selecting just 1 problem.
Choosing the best solution and Gamification	Evaluate to come up with the best solution. The criteria are used to evaluate solutions, allowing students to jointly evaluate solutions to achieve the best solution. If a student selects a problem in accordance with the process skills assessment criteria at this stage, 1 point will be awarded.
Presentation stage of future solutions and Gamification	Presenting the best solution for students to propose the best solution. It explains how to solve the problem. How does it actually work? Why does this solve the problem of the learner. If the student selects a problem in accordance with the assessment criteria for process skills, at this stage 1 point will be awarded and at this stage the student has completed all 3 points and can be redeemed for rewards.

2. The motive achievement test which developed by the researchers based on McClelland (1965). There are 6 aspects: risk taking courage/decision making, willingness to learn, responsibility, participation and cooperation, patience at work, and work planning. It is an estimation scale of 5 levels: Very low, Low, Moderate, High, and Very high.

3. The observation of learning achievement motivation. It is an observation of students' motive achievement behavior which developed by the researchers according to McClelland (1965). There are 6 aspects: risk taking courage/decision making, willingness to learn, responsibility, participation and cooperation, patience at work, and work planning. It is an estimation scale of 5 levels: Very low, Low, Moderate, High, and Very high.
4. Interviewing form about motive achievement which was created by the researchers to collect information about the practice of learning activities. Classroom atmosphere, advantages, shortcomings of each learning activity plan. It is used for students who do not meet the criteria as information to reflect on performance at the end of each operating cycle, a total of 8 items.
5. Learner's diary form to record the learning process that reflects the teacher's learning process from the students to any problems or obstacles that arise during the class.

Data collection

This research is action research (Altrichter et al., 2002) in which the researchers conducted, which consists of 4 stages: Plan, Act, Observe, and Reflect. The researchers divided the data collection operation into 3 cycles as shown in Figure 1.

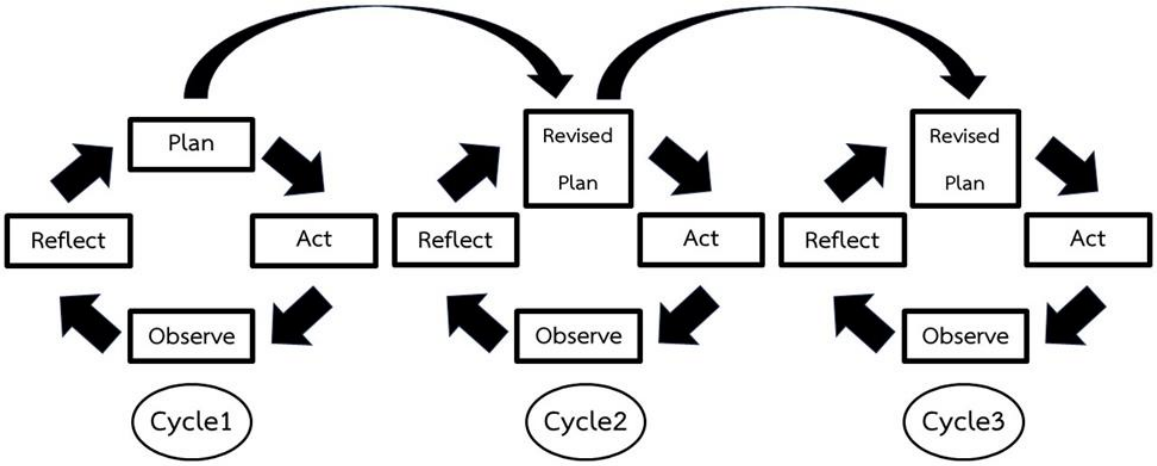

Figure 1. Cycles of classroom action research

Cycle 1: We observed the class and collected data on the motivation problems of Grade 11th students by using the motivative test to analyze the target students. Students with less than 70% of motivational scores will be the target group of this research. Then, learning management plans 1, 2 and 3 will be applied in cycle 1. At the end of the cycle, the data obtained from the data collection, including the motivative achievement test and observation of motivation for academic achievement, interview forms, and student's diary, will be analyzed and summarized for improvement and development of learning management design in the 2nd cycle.

Cycle 2: We summarized the data after reflection in cycle 1 and then revised the learning management plan 4 and 5, which collected data like cycle 1. The data obtained is then analyzed and summarized for improvement, correction and development of learning management design in the 3rd cycle.

Cycle 3: We summarized the data after reflection on the results in cycles 1 and 2 and then revised the learning management plan 6 and 7, which collected data like cycle 2 by applying the updated learning management to the target students. The data obtained is then analyzed and the results of the research are summarized.

Data analysis

We have divided the data into 2 categories:

1. Qualitative data: Use the information obtained from the records after the learning plan, the diary and the interview form. The data will be collected after the end of each learning cycle, and the researcher will use the data to reflect on the performance to reveal the problems and obstacles in the research and improve the learning management plan in the next cycle by analyzing, interpreting, summarizing the results, and then reporting the results in the form of lectures.
2. Quantitative data: Use the data obtained from the self-assessment of motive achievement. Data were obtained from the observation of motivation by the researchers in each cycle to analyze the level of motivation. Using basic statistics including frequency, percentage, mean and standard deviation, the data analysis interpretation stage is based on the average score of the grade range and then compared to the specified criteria. Passing the 70% or 3.50% or higher score out of 5 Likert scale as follow. Mean score ranged 4.50-5.00: Very high, 3.50-4.49: High, 2.50-3.49: Moderate, 1.50-2.49: Low, and 1.00-1.49: Very low.

RESULTS AND DISCUSSION

The study can be reported that Cycle 1 : Moderate level of motivation for overall student achievement. The moderate level of motive achievement in each area is as follows: risk taking courage/decision-making, intention to learn, responsibilities, participation and collaboration, endurance at work, and work planning. In the first cycle, 5 students who passed or 25% observed the level of motivation for academic achievement at a moderate level. From receiving knowledge from teachers, they must be self-investigating and from several student's diary would like to have more rewards.

Student motivative achievement, 5 students were successful in the first cycle because they were engaged with lesson and learning activities. After learning, students were done their tasks with doing independent research. This suggests that students should not rely entirely on teachers to get knowledge but should also make the effort to research and comprehend concepts on their own. In essence, the phrases emphasize the relationship between student agency, intrinsic drive, and academic success. The need for self-investigation of students indicates a more active approach to learning in contrast to the potential dependence on external motivators suggested by the need for additional incentives. Teachers and politicians may use these findings to better understand how to motivate and support their students in the classroom (Table 2).

Table 2. Student's motivation for academic achievement in each cycle

Cycle	Mean	S.D.	Qualified students	Level for motive achievement
1	3.35	0.71	5	Moderate
2	3.45	0.58	11	Moderate
3	3.53	0.51	15	High

Cycle 2 : Moderate level of motivation for overall student achievement, interviews with 9 unqualified students, it was found that during this research period, students had a large amount of workload from school and other subjects, making them more anxious about that burden than they were doing. Then, Cycle 3 : High level of motivation for overall student achievement. In an interview with 5 unqualified students, it was found that they were satisfied with their scores as the end of the semester of this academic year was near. In addition, the activity and workload are quite large, making it impossible to study at full capacity. And according to the diary, most students love the game that the researcher uses to collect scores at the end of class hours (Figure 1).

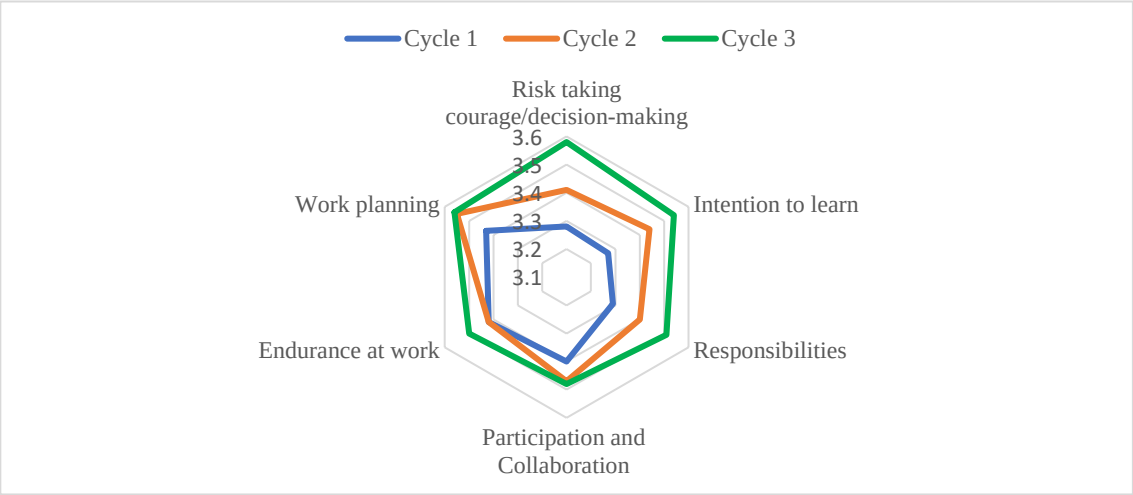

Figure 1. Achievement motivation levels in each cycle

In conclusion, at the end of all three operating cycles, A total of 15 students out of the target 20 students were found, or 75%. The highest level of motivation for academic achievement is risk taking courage/decision-making. This is followed by the work planning and intention to learn. Therefore, learning activities based on the process of thinking about solving future problems based on the concept of Torrance together with gamification (Aljraiwi, 2019). It helps to promote the motivation level of learners' academic achievement (Gianni & Antoniadis, 2023). This allows students to take risks and make decisions, and willing to learn, responsible, patient at work, cooperative and involved in classes and systematic work planning. This makes teaching and learning more efficient as well as satisfaction in organizing learning activities, learners become more enthusiastic, happy, and fun in studying (Rosa-Castillo et al., 2022; Wirani et al., 2022).

In science teaching, action research-based gamification is promising for student engagement and motivation. This review of studies shows that gamification makes learning more engaging. Gamification's Applications motivate science learning, according to students and parents (Hursen & Bas, 2019). Action research iteratively improves gamified learning tactics, making them more successful (Belova, 2021; Talib et al., 2017). Gamification in higher education improves student engagement and reduces attrition, meeting modern educational needs (Noran, 2016). Action research frameworks identify gamification strategy strengths and shortcomings, enabling specific teaching practice changes (Talib et al., 2017). Gamification has many benefits, but some educators may struggle to integrate it into their curricula, stressing the need for continual support and training in gamification tools (Arifin et al., 2022). Research was done in 3 cycles. Cycle 1 saw 25% of students pass. In Cycle 2, 55% of students passed. In Cycle 3, 75% of students pass. These cycles have demonstrated the effectiveness of Torrance's concept and gamification in boosting motivation and achievement. The study's findings have the potential to motivate students in science classes. Teachers can incorporate these methods into their classrooms.

The backdrop of these cycles of operation and the criteria for selecting pupils are of paramount importance. The ability to take calculated risks and make tough choices has been recognized as the single most important factor in students' success in the classroom. Planning work and having a genuine interest in learning are often cited as significant contributors to student motivation (Hoidn & Reusser, 2020). This points to the importance of risk-taking and decision-making traits in students' motivation (Li et al., 2019). The paper suggests that incorporating elements of game theory, the notion of Torrance (presumably referring to creativity measurements), and problem-based learning into the classroom might help boost student engagement and motivation. It is proposed that these factors work together to encourage risk-taking, autonomy, and active learning in the classroom.

Students develop traits like eagerness to learn, responsibility, patience, collaboration, and methodical task planning because of engaging in the mentioned learning activities. This points to a change for the better in students' conduct and outlook, which may be ascribed, at least in part, to the new instructional methods.

It is argued that the suggested method would improve the effectiveness of education. It is said that students would become more passionate, cheerful, and like studying if they are given a greater role in planning their own learning activities. The phrases together imply that student motivation, conduct, and academic success may all benefit from a curriculum that places equal emphasis on problem-solving, creativity, and gamification. The emphasis on initiative, self-determination, and positive traits is indicative of a more comprehensive approach to teaching (Riedmann et al., 2022). However, it is difficult to assess the validity of the methodology, data analysis, and generalizability of the results without access to the whole research. For a complete grasp of the study, readers should evaluate the whole article's context and specifics. However, teaching and learning should involve students in expressing themselves and acting on their own, such as writing explanations on paper (Li et al, 2019). Teaching or activities to develop motivation for academic achievement. The instructor should be friendly, smiling. Teachers also give students the opportunity to ask questions to create a relaxed atmosphere.

CONCLUSION

This study, conducted over three cycles, demonstrated a significant improvement in students' achievement levels when applying Torrance's concept in conjunction with gamification. In the first cycle, 25% of students met the success criteria, which increased to 55% in the second cycle and 75% in the third cycle. These findings indicate that integrating gamification with creative problem-solving strategies effectively enhances students' motivation and learning outcomes. The results suggest that the instructional approach utilized in this study can serve as a powerful tool to foster intrinsic motivation and authentic learning experiences in science education. By employing these strategies, teachers can encourage students to actively engage with the subject matter and overcome learning barriers. This research contributes to the growing body of literature on gamification and creative problem-solving by providing evidence of their combined effectiveness in improving educational outcomes. Future studies may explore the scalability and adaptability of these strategies across different subjects and educational contexts to further validate their impact.

AUTHOR CONTRIBUTIONS STATEMENT

Punyawee Duanyai was responsible for designing the research, developing the theoretical framework, and the methodology. They also took the lead in data collection, analyzing the results, and writing the introduction and conclusion sections. Additionally, the first author managed the revision process and communication with the journal.

Prasart Nuangchalerm contributed to developing the research instruments, data processing, and writing and editing the methodology and discussion sections. They also handled reference management, conducted the literature review, and provided critical feedback on the overall manuscript.

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