

Teachers' Practices and Students' Experiences of Gamification in High School Science Classes

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Abstract

Gamification is increasingly used in science education to support engagement, motivation, participation, and collaborative learning. However, less attention has been paid to how high school science teachers implement gamified elements in classroom practice and how students experience them during science learning. This qualitative descriptive study explored the gamification practices of six in-service science teachers and the experiences of thirty high school students from three public secondary schools in the Division of Iligan City. Data were gathered through a preliminary survey and semi-structured interviews and analyzed using thematic and comparative analyses. The study aimed to identify observable teacher practices in implementing gamification, describe student experiences in terms of engagement, motivation, clarity, fairness, and perceived learning, and compare areas of alignment and mismatch between teacher intentions and student experiences. Findings revealed that teachers used points, badges, missions, challenges, narratives, rewards, feedback, and progression systems to structure science tasks and promote engagement, collaboration, and meaningful participation. Students generally experienced gamified science lessons as enjoyable, interactive, collaborative, and motivating; however, unclear mechanics, time pressure, confusing scoring systems, and excessive competition sometimes hindered conceptual understanding. The comparative analysis showed that gamification can support high school science learning when game elements are clearly structured, aligned with curriculum objectives, inclusive, fairly paced, supported by feedback, and focused on learning rather than solely on rewards or competition.

Keywords: Gamification, science education, student engagement, teacher practices, student experiences

1. Introduction

Science education requires learning experiences that support motivation, awareness of performance, and strategic learning behaviors. Motivation shapes the effort students invest in learning, while performance awareness and metacognitive monitoring help learners recognize their progress, strengths, and difficulties in science (Arianto & Hanif, 2024; Torres et al., 2020; Winberg & Palm, 2021). Despite the importance of scientific literacy, many students continue to perceive science as abstract, difficult, and disconnected

from everyday life, which can reduce interest and participation in secondary science classes (Naiker et al., 2020; Potvin & Hasni, 2014).

Gamification has been introduced as one instructional approach for making science learning more interactive and participatory. It refers to the use of game-design elements in non-game contexts, such as points, badges, levels, missions, challenges, leaderboards, feedback, rewards, and progress indicators (Deterding et al., 2011; Werbach & Hunter, 2012). In classroom practice, these elements may support engagement by giving learners clear goals, visible progress, recognition, and opportunities for collaboration. However, research cautions that gamification does not automatically improve learning; its effects depend on the design of the activity, the duration of implementation, the learner context, and the alignment between game elements and instructional goals (Dichev & Dicheva, 2017; Hamari et al., 2014; Sailer & Homner, 2020; Zeng et al., 2024). Despite growing interest, evidence remains limited regarding how gamification is actually enacted in high school science classrooms and how students experience it relative to teachers' intended practices.

Several mechanisms explain how gamification may support science learning. From the perspective of Self-Determination Theory, game elements may support motivation by enhancing learners' competence, autonomy, and relatedness (Ryan & Deci, 2000). Badges, performance graphs, and leaderboards may influence perceived competence and task meaningfulness when they are used carefully (Sailer et al., 2017). Meanwhile, meaningful gamification emphasizes that rewards should not be the only driver of participation; rather, learners should experience relevance, choice, reflection, and personal connection to learning (Nicholson, 2015). In science instruction, this means that game elements should help students explain concepts, interpret evidence, construct models, solve problems, and reflect on their understanding, instead of merely collecting points.

The implementation of gamification also requires pedagogical alignment. The Learning Mechanics–Game Mechanics model emphasizes the need to translate learning goals and pedagogical actions into game mechanics that serve an instructional purpose (Arnab et al., 2015). Similarly, constructive alignment in game design requires coherence among intended learning outcomes, learning activities, game mechanics, and assessment (Kalmipourtzis & Romero, 2020). For high school science teachers, this alignment is important because science lessons often involve abstract concepts, inquiry processes, evidence-based reasoning, and conceptual explanations. When game mechanics are unclear, overly competitive, or unrelated to the science objective, students may focus more on winning than on understanding the lesson.

Teacher practices and lived classroom experiences are therefore central to understanding gamification. Teachers decide which game elements to use, how to connect them to curriculum competencies, how to organize group work, how to manage time and fairness, and how to provide feedback. Prior work on teacher adoption of gamification suggests that implementation is shaped not only by positive attitudes toward gamified learning, but also by classroom constraints, preparation time, available resources, student readiness, and teachers' ability to balance motivation with learning outcomes (Yaşar et al., 2020). Thus, examining the perspectives of teachers and students together can reveal whether teachers' pedagogical intentions align with students' actual experiences of gamified science activities.

Guided by this context, the study aimed to examine how high school science teachers use gamification and how high school students experience it in actual science classrooms. Specifically, it sought to: (1) identify the observable game-design elements and implementation strategies used by high school science teachers; (2) describe students' experiences of gamified science learning in terms of engagement, motivation, participation, clarity, fairness, and perceived learning; (3) compare the alignment and mismatch between teachers' practices and students' experiences; and (4) generate practical

design considerations for a measurable and observable science gamification framework for high school science classes. By addressing both teacher practices and student experiences, the study responds to the need for context-specific evidence on how gamification is designed and experienced in high school science lessons.

The scope of the study was limited to six in-service science teachers and thirty high school students from three public secondary schools in the Division of Iligan City. The study focused on reported practices and experiences of gamified science instruction and did not measure student achievement, long-term motivation, or teacher performance using quantitative indicators. The findings are therefore not intended for broad generalization across all school contexts. Instead, they provide a context-specific qualitative account that may inform future framework development, classroom implementation studies, and professional development activities on gamified science instruction.

2. Methodology

2.1 Research Design

This study used a qualitative descriptive research design to investigate the gamification practices of high school science teachers and the gamification experiences of high school students. A qualitative descriptive design is appropriate when the goal is to provide a direct description of participants' practices, perceptions, and experiences in real contexts (Kim et al., 2017; Sandelowski, 2000). This design was suitable because the study aimed to describe how gamification was implemented and experienced in actual science classrooms, rather than test causal effects or measure achievement gains.

Teacher and student data were analyzed separately and then compared to identify areas of convergence, complementarity, and mismatch. This comparative analysis helped determine whether the game elements and instructional intentions reported by teachers aligned with students' experiences of gamified science lessons. The comparison also identified practical design considerations related to engagement, collaboration, motivation, feedback, clarity, fairness, pacing, and conceptual learning.

2.2 Participant and Setting

The study involved six (6) classroom science teachers from three public secondary schools in the Division of Iligan City. These schools follow the K-to-12 Science Curriculum mandated by the Department of Education and serve as actual classroom contexts where gamified science activities have been used. Teacher participants provided data on the game elements they used, the ways they designed and organized gamified activities, and the challenges they experienced in science teaching. Thirty (30) high school students were also included to describe their experiences of gamified science lessons in terms of engagement, motivation, participation, clarity, fairness, and perceived learning.

The sample size and setting were appropriate for qualitative description, but they also represent important limitations. The study was limited to a small group of teachers and students from three public secondary schools in the Division of Iligan City; therefore, the findings should be interpreted as context-specific rather than generalizable to all high school science classrooms. In addition, the study relied on interview data and did not include direct classroom observation or quantitative measures of achievement.

2.3 Research Instruments

The study used a preliminary survey and semi-structured interview guides. The preliminary survey identified eligible participants and collected background information on familiarity with gamification, prior experience with gamified activities, and willingness to participate. The Teacher Interview Guide included open-ended questions on teachers' perceptions of gamification, specific game elements used, implementation procedures,

benefits, challenges, feedback practices, and design considerations. The Student Interview Guide gathered students' experiences with gamified science lessons, including enjoyment, motivation, participation, collaboration, clarity of mechanics, fairness, and learning challenges.

The semi-structured format allowed the researcher to ask follow-up questions and probes, enabling participants to elaborate on their experiences. This was important because the study sought not only to list game elements but also to understand how these elements were implemented and experienced in science classrooms.

2.4 Data Analysis

Thematic analysis was used to interpret the qualitative data from teacher and student interviews (Braun & Clarke, 2006). Interview transcripts were read repeatedly for familiarization, coded, grouped into initial categories, reviewed, refined, and organized into themes. To strengthen credibility, the themes were supported by participant excerpts and were compared across teacher and student data sources (Nowell et al., 2017).

For teacher data, the analysis focused on observable implementation practices, including the use of points, badges, missions, challenges, narratives, feedback, group roles, progression systems, and classroom management strategies. For student data, the analysis focused on how learners experienced these practices in terms of enjoyment, motivation, collaboration, clarity, fairness, time pressure, competition, and perceived understanding. The comparative analysis then examined whether teacher-reported practices aligned with students' reported experiences and where mismatches occurred.

3. Results and Discussion

3.1 In-service Secondary Science Teachers Gamification Practices in Science Classes

The interview data showed that teachers implemented gamification as a structured instructional practice rather than as an isolated classroom game. Their practices included the use of points, badges, levels, missions, rewards, feedback, quests, and progression systems to organize science tasks and sustain participation. These findings indicate that gamification was used to make science lessons more interactive while still maintaining a connection to instructional goals. This is consistent with literature emphasizing that gamification becomes educationally meaningful when game mechanics are intentionally linked to learning processes and objectives (Arnab et al., 2015; Kalmpourtzis & Romero, 2020).

Table 1 In-Service Secondary Science Teachers' Gamification Practices

Theme	High School Science Teachers Gamification Practices	Representative Evidence from Teachers'
Game as Structured, Game-Informed Science Instruction	Teachers used points, badges, levels, quests, narratives, station tasks, and digital or non-digital missions to structure science lessons.	Teachers reported using an Evolution expedition, Save the Body Mission, Earth's Core: Operation Seismic, and point systems for Physics tasks.
Gamification as a Driver of Active, Collaborative, and Meaningful Science Learning	Teachers used group challenges, problem-solving activities, and peer interaction to shift students from passive listening to active participation.	Teachers described students as becoming more curious, collaborative, and involved in science tasks.

Theme	High School Science Teachers Gamification Practices	Representative Evidence from Teachers'
Designing for Alignment, Feedback, and Inclusive Progression	Teachers emphasized starting with the learning objective, linking game elements to science goals, providing feedback, and adjusting difficulty or roles.	Teachers stated that game elements must serve the learning objective and that feedback should guide students beyond right-or-wrong answers.
Navigating Practical and Pedagogical Constraints	Teachers reported difficulties related to time, workload, technology access, unclear instructions, competition, fairness, and students focusing on winning.	Teachers responded by simplifying instructions, using collaborative tasks, starting small, and reusing or adjusting gamified materials.
Building Sustainable, Flexible Frameworks for Future Science Teaching	Teachers recommended flexible, curriculum-aligned, practical, and low-barrier gamification frameworks with templates, feedback systems, and reflection prompts.	Teachers emphasized the need for clear goals, mastery paths, adaptable game elements, and guidance that can work in both high-tech and low-tech classrooms.

Table 2 shows the practices of teachers in high school science gamification captured in five key themes. The first theme, Game as Structured, Game-Informed Science Instruction, shows that teachers understood gamification as an organized instructional strategy. They did not describe it simply as playing games; rather, they used game elements to structure science lessons into missions, challenges, levels, and progress-based tasks. Examples included a narrated Evolution expedition, station-based “Save the Body Mission,” a digital Earth science game using RPG Maker MV, and a point system in a Physics unit on forces. These examples address how gamification elements were implemented: narratives introduced the problem context, stations organized tasks, points and badges marked progress, and challenges required students to answer or solve science-related tasks.

The second theme, Gamification as a Driver of Active, Collaborative, and Meaningful Science Learning, indicates that teachers used gamification to promote active participation, teamwork, peer learning, and problem solving. Teachers reported that quiet or passive students became more willing to participate when tasks were structured as shared challenges. This suggests that gamification supported classroom participation not only through rewards but through social learning and problem-centered activity. Such use is consistent with research showing that gamification can support motivation and learning when it creates active, meaningful, and goal-directed learning experiences (Kalogiannakis et al., 2021; Sailer & Homner, 2020).

The third theme, Designing for Alignment, Feedback, and Inclusive Progression, highlights teachers' awareness that game elements must be tied to science objectives. Teachers repeatedly stated that gamified tasks should begin with the learning objective and that points, badges, and challenges should reinforce conceptual understanding rather than distract from it. Their practices also included immediate feedback, visual progress indicators, adaptive difficulty, retries, and reflection prompts. These practices show that teacher performance in gamification was reflected not in entertainment value alone, but in the extent to which teachers aligned game elements with learning actions, feedback, and student progression.

The fourth theme, Navigating Practical and Pedagogical Constraints, shows that teachers experienced challenges in implementing gamification. These included technical difficulties, limited internet or devices, extra preparation time, classroom management

concerns, unclear instructions, fairness issues, and the risk of students focusing more on points than on science. Teachers addressed these issues by simplifying directions, starting with smaller gamified elements, using collaborative formats instead of purely individual competition, and reusing activities that had worked previously. These findings show that gamification requires classroom management and instructional judgment, not just the selection of game elements.

The fifth theme, Building Sustainable, Flexible Frameworks for Future Science Teaching, reflects teachers' need for a practical framework that can be adapted to different science topics and classroom conditions. Teachers recommended clear objectives, feedback systems, mastery paths, templates, flexible game pieces, low-barrier setup, and reflection prompts. These recommendations show that teachers valued gamification when it was sustainable and curriculum-aligned rather than burdensome. Overall, teacher practices suggest that effective gamification in science requires clear alignment with science goals, manageable design, inclusive participation, and feedback-driven progression.

3.2 High School Students gamification experiences in Science Classes

The student interviews revealed that gamified science lessons were generally experienced as enjoyable, interactive, collaborative, and motivating. Students reported that gamified activities felt different from traditional lectures because they involved participation, teamwork, challenges, points, and recognition. However, their responses also showed that the same gamification elements could become barriers when rules were unclear, pacing was too fast, or competition became excessive.

Table 2. High School Students' Experiences in Science Gamification

Theme	Student Experience Identified	Illustrative Evidence
Gamified Science Made Learning Enjoyable and Engaging	Students described gamified lessons as fun, interactive, active, and different from ordinary note-taking or lectures.	Students stated that activities made science easier to understand because they performed tasks rather than only memorized content.
Collaboration, Challenge, and Competition Promoted Active Participation	Students enjoyed team competitions, quiz challenges, group tasks, and problem-solving activities because these encouraged cooperation and participation.	Students valued group quizzes, puzzle games, and team challenges where they shared ideas and solved tasks together.
Rewards and Feedback Enhanced Motivation and Engagement	Students felt motivated by points, badges, prizes, progress, and recognition because these made effort visible.	Students reported that points and badges helped them feel achievement and encouraged them to participate actively.
Unclear Mechanics and Time Pressure Hindered Conceptual Understanding	Students experienced confusion when instructions, rules, scoring systems, or time limits were unclear or too demanding.	Students reported focusing more on points or rushing answers when mechanics were confusing or time was limited.
Students Preferred Clearer, More Inclusive, and Learning-Centered Gamified Design	Students suggested clearer instructions, more time, hints, reflection, fairer participation, and less pressure from competition.	Students wanted everyone to participate and preferred activities where learning remained more important than winning.

Table 2 shows the experiences of students in high school science gamification captured in five key themes. The first theme, "Gamified Science Made Learning Enjoyable and Engaging," shows that learners valued the shift from passive listening to active participation. Students described gamified lessons as fun, interesting, interactive, and easier to understand because they involved completing tasks, responding to challenges, and interacting with classmates. This suggests that gamification helped increase students' willingness to participate in science activities by making learning more active and less routine.

The second and third themes likewise show that collaboration, challenge, competition, rewards, and feedback were important sources of participation and motivation. Students enjoyed group quiz bowls, puzzle games, team challenges, and point-based activities because these encouraged cooperation and shared responsibility. Rewards such as points, badges, and recognition helped students see their effort and progress. These findings align with the view that gamification can support cognitive, motivational, and behavioral outcomes when it is connected to meaningful learning experiences (Sailer & Homner, 2020).

In contrast, the fourth theme shows that gamification can also interfere with conceptual understanding when mechanics are unclear or when time pressure becomes excessive. Students reported that confusing rules, complicated scoring systems, strict timers, and unfamiliar scientific terms sometimes caused stress and diverted attention from understanding the lesson. These experiences support the need for clear instructional guidance and careful management of cognitive load in gamified learning environments (Arnab et al., 2015; Kalmpourtzis & Romero, 2020).

Taken together, the fifth theme indicates that students preferred gamified science activities that were clearer, fairer, more inclusive, and more learning-centered. Their suggestions included explaining rules before the activity, providing more time and hints, giving post-game discussion, ensuring equal participation, using cooperative tasks, and reducing pressure from rankings or leaderboards. These findings show that students did not simply want more games or rewards; they wanted gamified activities that helped them understand science better.

3.3 Comparative Analysis of Teachers' Practices and Students' Experiences in Gamification

The comparative analysis showed strong alignment between teachers' practices and students' experiences across engagement, participation, collaboration, and motivation. Teachers used gamification to structure lessons through points, missions, challenges, rewards, feedback, and progression systems, and students found these features enjoyable, interactive, and motivating. Both groups recognized the value of teamwork and challenge-based tasks in making science learning more active and meaningful.

At the same time, the comparison revealed important mismatches. Teachers emphasized technical difficulties, workload, preparation time, alignment with objectives, and classroom management, whereas students emphasized unclear instructions, confusing mechanics, time pressure, scoring systems, and intense competition. This indicates that while teachers may design gamified activities to increase engagement, students' learning experiences may be undermined when the mechanics are not transparent or when competition becomes more salient than the science task.

Overall, the comparative findings suggest that effective gamification in high school science requires more than adding points, badges, or rewards. It requires a clear instructional structure, alignment with science competencies, fair participation, manageable pacing, meaningful feedback, and opportunities for collaboration and reflection. These findings provide a basis for developing an observable science gamification framework with indicators such as the alignment of game elements with

learning objectives, the clarity of mechanics, the quality of feedback, the inclusivity of participation, the pacing, and evidence of conceptual understanding.

4. Conclusions

The study found that high school science teachers used gamification as a deliberate instructional approach rather than as entertainment alone. Teachers applied game elements such as points, badges, levels, missions, challenges, rewards, feedback, and progression systems to structure science lessons and promote participation. Their practices indicated that gamification becomes more educationally meaningful when it is connected to science learning objectives, feedback, collaboration, and conceptual understanding.

Students generally experienced gamified science lessons as enjoyable, interactive, collaborative, and motivating. They appreciated activities that allowed them to work with peers, respond to challenges, receive recognition, and monitor progress. However, students also identified problems related to unclear instructions, confusing mechanics, time pressure, scoring systems, and competition. These difficulties sometimes caused them to focus more on points or speed than on understanding the science lesson.

The comparative analysis revealed that teacher intentions and student experiences aligned on engagement, motivation, participation, and collaboration, but differed in how implementation challenges were experienced. Teachers focused more on planning, workload, technology, and alignment, while students focused more on clarity, pacing, fairness, and conceptual understanding. Therefore, the study concludes that gamification can support high school science learning when it is carefully designed, clearly explained, curriculum-aligned, inclusive, fairly paced, and focused on learning rather than solely on rewards or competition.

The study also concludes that future science gamification frameworks should include observable and measurable indicators. These may include the alignment of game elements with science objectives, clarity of instructions, fairness of participation, quality of feedback, appropriateness of pacing, collaboration, inclusivity, and evidence of conceptual understanding. Such indicators can help teachers evaluate whether gamification is functioning as an instructional support rather than as a distraction.

5. Recommendations

Science education requires meaningful learning experiences yet many students still perceive science as difficult, abstract and less connected to real life. To address this, this study explored the gamification practices of high school science teachers, and students' experiences with gamified science lessons in terms of engagement, motivation, participation, clarity, fairness, and learning.

1. Teachers should align gamified activities with science learning objectives.
2. Teachers should provide clear instructions, mechanics, scoring systems, and pacing.
3. Schools should support teachers in implementing gamified science instruction.
4. Future studies may develop a Science Gamification Framework.

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