DIGITAL BADGES AS REWARDS IN SCIENCE EDUCATION: STUDENTS’ PERCEPTIONS AND EXPERIENCES

Aaron A. Funa*

*Sorsogon State University, Sorsogon, the Philippines
*Corresponding author: Email: funa.aaron@sorsu.edu.ph

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Abstract

Several studies have reported positive effects of digital badges on students’ academic performance and behavior. A digital badge serves as an indicator of an accomplishment or skill that can be showcased, accessed, and verified online. The researcher investigated how students perceive digital badges as rewards in a biology course through a phenomenological study. Gamified lesson plans and students’ portfolios were used to implement gamification and award digital badges. The study involved Filipino Grade 12 STEM students (n = 41) from a single intact class, and interviews were conducted with a subset of 10 students. By analyzing student responses in their portfolios and interviews, four key themes of digital badges were identified: class participation, learning outcomes, time management, and social interaction. The results revealed that these themes were influenced by factors such as competition, a sense of accomplishment, self-improvement, status recognition, and evidence of achievement. It was found that, while digital badges can be beneficial for high-performing students, they may have detrimental effects on low-performing students. The researcher recommended that the identified themes and their underlying drivers be considered when developing digital badges and in future studies on digital badges and gamification.

Keywords: Biology education; Digital badges; Gamification; Pedagogy; Science education.

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1. INTRODUCTION

Badges are optional rewards and goals that can be acquired by players of a game. They encompass distinctive elements, including visual and textual cues, specific rewards, corresponding points, and criteria that define how each badge can be earned (Hamari, 2017). When integrated with points and leaderboards, badges can serve as a gamification element. Consequently, they have been recognized as one of the top three motivational tools in gamification, alongside points and leaderboards (Gibson et al., 2015; Hamari et al., 2014). The inclusion of visuals, fulfillment conditions, narratives, and challenges linked to badges has been found to enhance students’ intrinsic motivation (Funa et al., 2021; Malone, 1981). Intrinsic motivation arises when individuals engage in an activity without the need for external rewards (Deci et al., 1981). Competency, autonomy, and self-determination are strongly associated with intrinsic motivation, leading to improved mental health, creativity, learning outcomes, and sustained student interest. Consequently, the utilization of badges for gamification in education is gaining popularity (Cerasoli et al., 2014; Ryan & Deci, 2000).

In addition, using badges as rewards for learning can also provide extrinsic motivation (Funa & Ricafort, 2019a; Gilyazova & Zamoschanskii, 2020). Incentive systems have been extensively employed in schools to motivate student learning, but external rewards can foster competition among students or groups (Deci et al., 2001). This competitive environment may have adverse consequences for student learning as students shift their focus toward winning rewards or outperforming others rather than genuine learning (Cagiltay et al., 2015; Deci et al., 1981; Funa et al., 2021). Removing rewards altogether after students have become accustomed to them may decrease students’ motivation to learn. Furthermore, the long-term use of badges as rewards can lead to negative effects such as loss of novelty, fatigue, diminished excitement, and reduced intrinsic motivation (Hanus & Fox, 2015; Mekler et al., 2017). However, it is crucial to recognize that badges should not be relied upon as the sole motivator for learning; instead, they should be integrated with an effective course design and learning theories to sustain student engagement and reinforce learning opportunities (Finkelstein et al., 2013).

Stefaniak and Carey (2019) have highlighted numerous studies discussing the effects of badges on both extrinsic and intrinsic motivation among students. Glover (2013) argued that badges can be used to stimulate students who initially have low levels of intrinsic motivation. However, Funa et al. (2021) and Kyewski and Krämer (2018) have pointed out the challenge of linking the awarding of badges to an increase in students’ intrinsic motivation due to the inherent nature of badges as external rewards. Therefore, it is important to examine how students perceive the use of badges as rewards for learning to enhance their incorporation into various pedagogies, such as gamification and science education, while considering the impact on both extrinsic and intrinsic motivation.

As technology has become integrated into the learning and teaching process, there has been a shift from physical to digital forms of badges (Funa et al., 2021; Shields &
Chugh, 2017). According to Gibson et al. (2015), digital badges recognize talent, competencies, achievements, educational status, interests, and certifications. Teachers can award digital badges in online environments, including learning management systems (LMS), e-portfolios, digital badge backpacks, or social media platforms such as LinkedIn, Facebook, and Instagram (Funa et al., 2021; Shields & Chugh, 2017). Online platforms allow students to conveniently store, access, monitor, and display their digital badges. With the shift from physical to digital badges, it is intriguing to explore whether students’ perceptions of badges as a form of reward for learning have also evolved.

Overall, a digital badge is an indicator of an accomplishment or skill that can be displayed, accessed, and verified online. The purpose of this study was to investigate the perceptions of students regarding the use of digital badges in gamification in science education as rewards for learning and various academic accomplishments. Specifically, the researcher addressed the following questions: (1) What are the students’ perceptions of digital badges as rewards for learning biology concepts? and (2) What are the implications of digital badges for learning biology concepts based on students’ perceptions?

2. DATA AND METHODS

2.1. Research design

The researcher employed a phenomenological research design to investigate the perceptions and experiences of students regarding the use of digital badges as rewards for learning. This research design enabled the researcher to delve deeply into the lived experiences of individuals in the context of the phenomenon in question, as articulated by the participants who had direct encounters with it (Creswell & Creswell, 2018). This design was well-suited to exploring the subjective and nuanced aspects of their engagement with this gamified educational tool.

2.2. Participants

The researcher employed a purposive intensity sampling technique to select participants for the study. This sampling technique involves deliberately choosing cases that provide a wealth of information and examples (Patton, 2002). From a population of 41 Filipino Grade 12 STEM students in a single intact class, 10 participants were selected as rich cases to participate in a series of interviews conducted after the lessons. By using purposive intensity sampling, the researcher aimed to select participants who could offer deep insights and diverse perspectives regarding their experiences with digital badges as rewards for learning biology. The researcher selected participants who represented extremes, including those who were highly enthusiastic about games and those who were least enthusiastic. The study included students with the highest, average, and lowest grades and with varied levels of motivation. The focus was on capturing a range of responses and rich information from the selected participants, allowing for a comprehensive exploration of their perceptions and experiences.

Additionally, another source of data was provided by the reflective journals completed by all 41 students as part of their student portfolios. The combination of
interviews and reflective journals provided multiple data sources to gain a holistic understanding of the students’ perspectives on digital badges in science education.

2.3. Research instruments

Two key tools were employed in this study, both of which were adapted from prior studies by Funa and Ricafort (2019a, 2019b): the gamified lesson plan in genetics and the student’s portfolio. These instruments played pivotal roles in the study’s methodology, enhancing its comprehensiveness and effectiveness.

The gamified lesson plan in genetics encompassed a diverse array of topics related to genetics, such as pedigree analysis; sex linkage and recombination; modification of Mendel’s classic ratios; the molecular structure of DNA, RNA, and proteins; DNA replication and protein synthesis; genetic engineering; and discussions on the applications of recombinant DNA. This lesson plan provided a well-structured framework for implementing gamified activities in the context of genetics education. It also included detailed instructions for teachers on how to effectively use digital badges as part of the gamification process, such as in the game mechanics and in every activity.

The student’s portfolio served as a multifaceted tool that integrated various game mechanics and elements. These elements included badge backpacks, power cards, journal logs, character profiles and levels, records of points earned, and leaderboards. Essentially, the student portfolio was designed to capture a holistic view of students’ interactions with the gamified learning experience. It allowed students to accumulate and display their achievements, track their progress, and engage with the gamified content on multiple levels. Additionally, the student portfolio collected essay responses from students, providing valuable insights into their perceptions of the digital badges and their overall experiences with the lessons.

It is worth emphasizing that these instruments previously underwent validation by Funa and Ricafort (2019a, 2019b). The validation ensured that the tools were reliable and effective in assessing the impact of gamification and digital badges on student learning and motivation in the context of genetics education. As a result, these instruments played a crucial role in the research, contributing to the study’s credibility and robustness.

2.4. Data gathering procedures

Prior to gathering data, the researcher followed ethical standards and obtained permission from the relevant authorities to conduct the study at their institution. Once permission was granted, the researcher collaborated with the class adviser to organize an orientation session and collect signed consent forms from the students’ parents or guardians. Only students whose parents or guardians provided consent participated in the study.

During and after the implementation of the gamified instructional materials in genetics, the researcher conducted interviews with the participating students. The implementation phase of the study spanned 750 minutes, equivalent to 15 days of instructional time. To facilitate the implementation and management of the study, the
researcher used Schoology as a learning management system (LMS) and as a tool for awarding digital badges (Figure 1).

![Schoology interface for awarding digital badges to students](image)

**Figure 1. Schoology interface for awarding digital badges to students**

By using Schoology as an LMS, the researcher could effectively integrate the gamified elements and digital badges into the learning environment. This platform provides a structured and accessible system for tracking student progress, awarding badges, and managing the overall gamified learning experience. The use of Schoology as an LMS demonstrated the researcher’s commitment to leveraging technology to enhance the implementation and administration of the study.

The researcher designed a set of seven digital badges to be awarded to students based on their specific academic accomplishments (Table 1). Each badge has a unique name, point value, and award criterion. To earn a particular badge, students must successfully complete the corresponding task listed in Table 1. During the gamified lessons in genetics, the students strove to obtain as many badges as possible.

<table>
<thead>
<tr>
<th>Badge Name</th>
<th>Points</th>
<th>Award criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced</td>
<td>2,000</td>
<td>Player achieves 90 percent or above on a quiz or exam</td>
</tr>
<tr>
<td>Proficient</td>
<td>1,000</td>
<td>Player achieves 85 to 89 percent on a quiz or exam</td>
</tr>
<tr>
<td>Kindhearted</td>
<td>200</td>
<td>Player helps a struggling player during the lesson</td>
</tr>
<tr>
<td>Braveheart</td>
<td>500</td>
<td>Player correctly answers a question asked by the game master</td>
</tr>
<tr>
<td>Bookworm</td>
<td>1,000</td>
<td>Player completes an assignment on time</td>
</tr>
<tr>
<td>Energy Booster</td>
<td>1,000</td>
<td>Player performs an icebreaker or report and presents an activity in front of the class</td>
</tr>
<tr>
<td>Perfect Attendance</td>
<td>5,000</td>
<td>Player has perfect attendance and is never tardy during the game</td>
</tr>
</tbody>
</table>
The points earned from the badges obtained by each student were tallied, and the student with the highest total points was declared the winner of the game or received the ultimate reward. The details of the ultimate reward were not disclosed until the conclusion of the entire gamified lesson plan. This approach was adopted to heighten the excitement and anticipation among the students because the nature of the final prize remained unknown. By maintaining the mystery surrounding the ultimate reward, the researcher aimed to create an added element of suspense and engagement throughout the gamified learning experience.

The badges listed in Table 1 provide opportunities for students to earn recognition in various aspects of the class beyond traditional quiz or exam performance. They acknowledge acts of kindness, participation, timely completion of assignments, and consistent attendance during the gamified learning experience.

By introducing these badges, the researcher aimed to promote a sense of accomplishment, motivation, and engagement among students, recognizing their efforts and positive contributions both academically and socially. The inclusion of badges for different achievements broadens the scope of the gamification approach, allowing for a more comprehensive recognition system that goes beyond solely academic outcomes.

The data collected from the students’ portfolios and interviews were analyzed using a qualitative approach (Creswell & Creswell, 2018), focusing on the themes of class participation, learning outcomes, time management, and social interaction. The analysis involved coding and categorizing the data to gain insights into student perceptions of digital badges as rewards for learning. This comprehensive analysis of the compiled data follows the methods recommended by Creswell and Creswell (2018, 2023). The researcher identified patterns and connections within the data to provide a comprehensive understanding of student perspectives on digital badges in gamification.

3. RESULTS AND DISCUSSION

The analysis of student responses in their portfolios and during interviews revealed the presence of four key themes: class participation, learning outcomes, time management, and social interaction. Class participation pertains to the extent and manner in which students actively engage in classroom activities, discussions, and interactions during the lesson. Learning outcomes encompasses the changes in knowledge and behavior that students acquire and demonstrate as a result of their educational experiences (Funa et al., 2022). In this context, it refers to the impact of digital badges on students’ understanding of science concepts. Time management focuses on how students allocate and manage their time to meet academic requirements. It includes their ability to balance coursework, assignments, and other responsibilities, as well as the influence of digital badges on their time allocation and study habits. And lastly, social interaction relates to the extent and quality of students’ engagement with their classmates and teacher. It involves collaborative activities, communication, and the role of digital badges in facilitating or hindering social connections within the educational context. These themes provide valuable insights into the students’ perceptions and experiences related to the use.
of digital badges in science education. The subsequent discussion examines these themes, shedding light on the findings and implications derived from the students’ responses.

3.1. Class participation

The class participation theme reflects student engagement and involvement in the gamified learning activities. It encompasses their active participation during question-and-answer sessions, group discussions, and other interactive components of the gamified lessons. For example, when a student voluntarily provides a correct answer, they earn the “braveheart” badge, which is worth 500 points. Students expressed their appreciation for the opportunity to earn badges for their contributions to class discussions and their willingness to assist their peers. This theme highlights the positive role of digital badges in fostering a collaborative and participatory learning environment.

The responses of students 27 and 35 in their portfolios and during the interview shed light on the impact of awarding digital badges for class participation. Students 27 and 35 wrote in their portfolios that the digital badges stimulated their classmates to participate, making the learning experience fun and enjoyable. “The digital badges make learning fun and enjoyable. All of my classmates are excited to recite and participate in the lesson. But the lesson is sometimes hard to understand because of the noise” (Student 27, personal conversation). “The digital badges motivate me to participate and listen to every lesson. However, the class becomes too noisy because of too much cooperation. Others talk simultaneously, but it is good to see that my classmates are contributing during activities to obtain the digital badges” (Student 35, personal conversation).

In addition to their portfolio response, Student 35 elaborated during the interview that a significant change in the level of student participation during the lessons could be observed. “Napansin ko po talaga sir na mas maraming gustong magparticipate dahil nga gusto nila makakuha ng digital badges. Nagpaparamihan sila ng makukuhang badges. [I really noticed, sir, that more students want to participate because they want to get digital badges. They compete with each other to earn badges]” (Student 35, personal conversation). Student 35 mentioned during the interview that some students were competing and comparing the number of badges they obtained. This finding aligns with the study by Zhou et al. (2021), in which students perceived digital badges as a motivating factor for participation because they represent accomplishments and foster a sense of competitiveness.

On the other hand, Student 4 shared a different perspective, indicating a decrease in excitement and motivation over time. They mentioned feeling tired and discouraged from participating because they had earned fewer badges than their classmates. “At first, I was very excited to participate to obtain digital badges. Now, my excitement is lost, and I am tired to participate sometimes because I got few badges compared with my classmates who have far more badges obtained than me” (Student 4, portfolio entry, personal conversation). This finding is consistent with similar findings by Hanus and Fox (2015) and Mekler et al. (2017), which highlight the potential adverse effects of a long-term reward system on students’ intrinsic motivation and excitement. The presence of
competition among students may contribute to these negative effects, particularly for low-performing students who may feel discouraged or overwhelmed by the achievements of their peers (Funa et al., 2021). It is essential to consider the individual learning types and needs of students before implementing digital badges to ensure their effectiveness and prevent potential loss of motivation (Reid et al., 2015).

The findings from the students’ responses provide valuable insights into the complex dynamics of digital badges as motivators for class participation. While some students perceive them as stimulating and fostering competition, leading to increased engagement, others may feel fatigued or lose motivation when faced with challenges or comparisons with their peers. In addition, potential drawbacks, such as excessive competition or noise disruptions in the classroom, should also be considered when implementing digital badges as motivators. These results highlight the importance of carefully designing and implementing digital badge systems that consider individual differences and balance extrinsic and intrinsic motivation to ensure sustained student engagement and positive learning outcomes.

3.2. Learning outcomes

The learning-outcomes theme focuses on student perceptions of how digital badges influenced their learning progress and academic achievements. Students acknowledged the motivating effect of badges in driving their efforts to achieve higher scores on quizzes and exams. They recognized the value of badges as indicators of their academic accomplishments and expressed a sense of pride and satisfaction upon earning them. This theme underscores the potential of digital badges to enhance the intrinsic motivation of students and drive them toward achieving learning goals.

Several studies have demonstrated that the use of badges can have a significant positive impact on students’ academic performance (Funa & Ricafort, 2019a; Kalogiannakis et al., 2021). This finding is supported by the statements made by students 12 and 18 in their portfolios. They observed behavioral changes in themselves after the implementation of digital badges, which they believed contributed to an improvement in their academic performance. Student 12 mentioned feeling pressure to obtain a badge when they saw their classmates earning and comparing badges. This pressure motivated them to put in their best effort in school to achieve their goal. “When I saw my classmates gaining and comparing digital badges, I was pressured to obtain one and did my best in the school to get one” (Student 12, portfolio entry, personal conversation).

Student 18 expressed that, although they already had an interest in biology before the introduction of digital badges, the presence of badges motivated them to increase their efforts and dedicate more time to studying, resulting in improved grades. Additionally, the act of earning more badges gave them a sense of accomplishment and satisfaction. “Although I love[d] biology even before the existence of digital badges in the classroom, I still increased my effort and time to study and get high grades because I can see [from] my classmates that they also increase[d] their efforts. Further, obtaining more badges makes me feel better” (Student 18, portfolio entry, personal conversation). These findings
align with previous research indicating that digital badges can serve as external motivators that encourage students to strive for academic excellence and invest more effort in their studies (Funa & Ricafort, 2019a; Gilyazova & Zamoshchanskii, 2020). The competitive aspect of earning badges and the visibility of their peers’ achievements can create a positive social influence, motivating students to perform at higher levels.

The responses from students 12 and 18 in their portfolios highlight the influence of digital badges on behavioral changes that they believe have contributed to improved learning outcomes. Student 18 specifically mentioned an increase in effort and time allocated for studying the lesson, even though they were already performing well in the class. This demonstrates a proactive choice to elevate their efforts and dedicate more time to their studies. These behavioral changes can be attributed to peer pressure, indicating that the presence of digital badges and the visible achievements of their classmates motivated them to enhance their own learning behaviors. These findings are supported by a study by Tahir et al. (2022) that suggests that gamification, including the use of badges, can enhance learning outcomes through behavioral changes, particularly in terms of increased “time-on-task” or the amount of time spent actively engaging in the learning process. Students who earned fewer badges may have allocated less time to participating in and studying the lessons, whereas those who earned a greater number of badges may have invested more time in active participation and studying.

Student 16’s perspective offers a valuable insight into the potential drawbacks of an overly competitive badge environment. Student 16 (personal conversation) stated during the interview, “... sa sobrang competition sir masyado na akong nahihiyap na magsasabi ko sa kanya pero ako ng interest kasi nakakapagod mag-collect ng badges lalo na nakikita ko 'yung mga kasama ko, ang dami ng badges. [...]” Student 16’s response highlights the delicate balance that needs to be maintained when implementing digital badges as motivators in the classroom. While badges can serve as effective tools to encourage engagement and effort, an excessive focus on competition can lead to unintended consequences. Student 16’s experience underscores the potential for badges to create unhealthy competition among students. When the pursuit of badges becomes too intense, it can lead to stress, anxiety, and a loss of motivation. Students may feel overwhelmed by the pressure to collect badges, and this can negatively impact their overall learning experience (Hanus & Fox, 2015; Mekler et al., 2017). Moreover, the mention of losing interest in the subject matter due to the emphasis on badge collection raises a crucial concern. If the primary focus shifts from genuine learning and understanding to simply earning badges, the intrinsic motivation to learn can diminish (Funa et al., 2021). This shift may lead to superficial engagement with the material, where students are more concerned with badge accumulation than with deep comprehension and retention of knowledge.

Student 16’s perspective highlights the need for a balanced and thoughtful approach to the use of badges in the classroom. It is essential to create an environment in which badges serve as motivators for learning and collaboration rather than as sources of excessive competition and stress. Teachers should carefully consider the design and
implementation of badge systems to ensure that they enhance the learning experience and foster a positive, supportive learning environment. To mitigate the negative effects of competition, strategies such as emphasizing the value of collaboration, focusing on individual growth, and providing alternative forms of recognition beyond badges can help strike this crucial balance. In this way, badges can continue to motivate students without overwhelming them or detracting from their intrinsic interest in learning.

Another important aspect to consider is the response provided by Student 1, which highlighted a broader perspective on the impact of badges. Student 1 (personal conversation) stated, “...hindi lang po sa quiz ang badges, pati rin po sir sa pagiging collaborative, yung ‘kindhearted’ badge po, at yung ‘energy booster,’ nagiging creative kami sa pag-iisip ng icebreaker. [...] not only in quizzes, sir, but also in being collaborative [to earn] the ‘kindhearted’ badge and the ‘energy booster,’ we become creative in thinking of icebreakers.” Student 1’s response in the interview underscores a crucial point: that the influence of badges extends well beyond quiz scores. In this case, badges such as “kindhearted” and “energy booster” promoted collaborative and creative thinking among students. This finding has several implications for understanding the multifaceted role of digital badges in the learning process. First, the mention of the “kindhearted” badge suggests that badges can be used to foster positive social interactions and character development. This aligns with the idea that badges can serve as tools to encourage not only academic excellence but also the development of important soft skills, such as empathy and cooperation. Students may actively strive to earn these badges, which can promote a harmonious and empathetic classroom atmosphere. Additionally, the reference to the “energy booster” badge demonstrates how badges can inject enthusiasm and creativity into the learning environment. By challenging students to think creatively about icebreakers or energizing activities, badges can enhance engagement and participation. This creative aspect of badge-earning can contribute to a more dynamic and stimulating classroom atmosphere.

Furthermore, Student 1’s response underscores the potential of badges to shape the learning culture within the classroom. When students are motivated not just by quiz scores but by a wide range of badges that recognize various aspects of their behavior and character, it can create a more holistic learning experience. The classroom becomes a space where academic excellence, collaborative skills, kindness, creativity, and enthusiasm are all celebrated and encouraged.

These findings emphasize the potential of digital badges as a motivational tool to enhance learning outcomes and elicit positive changes in student behaviors, such as collaboration and creativity. The competitive element and peer influence associated with earning badges can encourage students to invest more time and effort in their studies, leading to improved academic performance. The results also highlighted the potential of
badges to shape not only academic achievements but also the broader educational experience, fostering well-rounded and engaged learners.

3.3. Time management

The time management theme pertains to students’ experiences in balancing their academic responsibilities and using their time effectively within the gamified learning environment. Students highlighted the importance of timely completion of assignments to earn specific badges. They recognized the role of badges in promoting a sense of urgency and accountability in managing their time. This theme emphasizes the influence of digital badges in encouraging students to develop effective time management skills and meet deadlines.

The researcher interviewed students 12 and 18 on how they effectively managed to increase the amount of time allotted for studying the lessons. “Isinisingit ko po yung pagbabasa ng notes at pagrereview pag may free time bago po ang klase. Para po makarecite ako at makakuha ng badges. [I squeeze in reading and reviewing my notes during my free time before class. This is so that I can actively participate and earn badges] (Student 12, personal conversation). Student 12 mentioned that whenever there is free time to study notes before the biology lesson starts, they take that opportunity to read and review past lessons to be able to participate and earn badges during classroom discussions. “Naghahanap po talaga ako ng oras mag-aral. Binabawasan ko yung mga leisure activities gaya ng paglalaro ng games sa phone. [I really look forward to the time when I get home to study. I reduce leisure activities like playing games on my phone]” (Student 18, personal conversation). For Student 18, properly scheduling time to study the lessons at home after classes is essential. To do this, time for leisure activities needed to be sacrificed.

The responses of students 12 and 18 support the idea that badges can be used as a tool to improve the soft skills of students, including time management (Ahn et al., 2014; Randall et al., 2013). These findings highlight the potential of digital badges as a means to foster valuable skills beyond academic knowledge, such as time management and self-discipline. By incentivizing students to invest more time and effort in their studies through the pursuit of badges, educators can help cultivate important lifelong skills that extend beyond the classroom.

In addition to allocating time for studying, the ability of students to effectively manage their time is reflected in their timely completion of assignments. Student 27 mentioned in the portfolio that because of the digital badges awarded to students who completed their assignments on time, they made sure to submit their work on time. “Among my subjects, I see to it that I first do my assignments in biology and submit it to my teacher tomorrow at the right time” (Student 27, personal conversation). This indicates that the badges act as an extrinsic reward that encourages students to meet deadlines and fulfill their academic responsibilities. These findings align with those of Haaranen et al. (2014), who suggest that incorporating badges related to time management can improve students’ awareness and sense of time. By incentivizing
students to submit assignments on time, the badges serve as tangible recognition of their ability to manage their time effectively.

However, it is important to consider potential trade-offs when using time management badges. Haaranen et al. (2014) also found that emphasizing time management may have adverse effects on the carefulness or quality of students’ work. Students might be more focused on meeting deadlines than on investing sufficient time and effort to produce high-quality answers on their first attempt. This phenomenon was exemplified by Student 32 (personal conversation), who stated during the interview, “… minsan sinsasubmit na naming yung mga activities para makakuha ng ‘bookworm’ badge … para iwas stress na rin, kaya lang yung quality ng gawa naming minsan talaga apektado. [...] sometimes we submit our activities just to earn the ‘bookworm’ badge ... to alleviate stress, but the quality of our work is sometimes compromised.” This observation underscores the importance of achieving a delicate balance when designing and awarding badges within a gamified learning environment. It is crucial to recognize and reward not only the timely completion of tasks but also the attainment of high standards in students’ submissions. This balanced approach ensures that students not only cultivate effective time management skills but also develop the ability to produce thoughtful, well-prepared, and high-quality work. Hence, educators may develop a well-defined badge criterion that not only emphasizes timely completion but also includes quality benchmarks. For example, badges could be awarded for meeting deadlines while achieving a certain level of accuracy, depth, or creativity in the work. In addition, it is important to consider flexible deadlines that allow students to manage their time according to their individual needs and learning styles while maintaining accountability by ensuring that there are consequences for consistently missing deadlines.

The goal is to foster a comprehensive learning environment in which students are motivated to manage their time efficiently while also striving for academic excellence. By encouraging both timeliness and quality, educators can create a dynamic educational atmosphere that promotes holistic skill development and empowers students to excel in their academic pursuits.

3.4. Social interaction

The social interaction theme centers around the students’ experiences of engaging with their peers within the gamified learning context. Students expressed how the gamified elements, such as assisting struggling players and performing icebreakers or presentations, fostered positive social interactions and strengthened their relationships with classmates. The badges associated with these social interactions were viewed as a means of recognition and encouragement. This theme underscores the potential of digital badges to promote collaboration, teamwork, and positive social dynamics among students.

The incorporation of digital badges in group activities within the gamified lesson plan has been observed to enhance interactions among group members, as mentioned by Student 25 in their portfolio. According to Student 25, the presence of badges adds an element of excitement to group activities, thereby promoting increased engagement and
interaction among group members. “The digital badges add to the flavor of the group activity, making it more exciting” (Student 25, personal conversation). This response aligns with the findings of Stefaniak and Carey (2019), whose study also indicated that badges could have a positive impact on social interaction among students. By introducing badges as rewards within the group activities, students are motivated to collaborate, communicate, and support each other in order to earn badges collectively.

The findings from Student 25’s portfolio entry (personal conversation) and the study by Stefaniak and Carey (2019) collectively support the notion that digital badges contribute to improved social interaction within group activities. By leveraging the motivational power of badges, educators can create a collaborative and engaging learning environment in which students actively interact, share ideas, and support one another to achieve their common objectives.

During the interview, Student 25 expressed their perception that increased social interaction among their peers is driven by various factors, including competition, self-satisfaction, excitement, and grades. Student 25 believed that the presence of competition motivates students to engage more with each other. “Feeling ko po, kaya tumataas ang interaction naming sa bawat isa ay dahil sa merong kumpetisyon .... Mas sikat at mas masaya kapag marami kang makuhang badges .... Nakakaexcite din kasi at siyempre gusto ko din makakuha ng mataas na grades sa subject po ninyo. [I feel that the reason why our interaction with each other increases is because of competition .... It feels more popular and enjoyable when you earn many badges .... It’s also exciting because, of course, I want to achieve high grades in your subject]” (Student 25, personal conversation). They also mentioned that obtaining a greater number of badges brings a sense of popularity and happiness. Furthermore, Student 25 expressed a desire to achieve high grades in the subject.

These sentiments align with the findings of Gibson et al. (2015), who noted that digital badges offer status recognition as one of their advantages. Digital badges serve as assessable artifacts that validate and accredit acquired knowledge, skills, or completed tasks. By earning badges, students can demonstrate their accomplishments and receive recognition for their efforts. The recognition provided by digital badges contributes to a sense of accomplishment and satisfaction among students. It motivates them to actively participate, engage with the learning materials, and interact with their peers to earn badges. This, in turn, promotes increased social interaction and collaboration within the learning environment. The combination of competition, self-satisfaction, excitement, grades, and status recognition through digital badges creates a dynamic and engaging atmosphere that encourages students to interact with one another, share their achievements, and strive for further success.

According to the responses of students 27 and 35, an increase in social interaction among students during class activities can lead to a noisy classroom environment. While social interaction is beneficial for student engagement and participation, excessive noise levels can hinder comprehension and concentration on the assigned tasks (Connolly et al., 2019). Student 35 specifically mentioned that their group faced difficulties understanding
each other and concentrating on their activity due to the noise generated by another group. This indicates that noise can disrupt effective communication and hinder the learning process. “... dahil po sa ingay ng kabilang grupo, hindi na po kami magkaintindihan at kapag sa ginagawa naming activity.” [...] because of the noise from the other group, we can no longer understand each other and concentrate on the activity we are doing] (Student 35, personal conversation). In light of these observations, it becomes essential for the teacher to intervene and manage noise levels in the classroom while still promoting social interaction.

Strategies such as setting clear expectations for noise levels, implementing group work protocols, and providing guidance on effective communication can help strike a balance between encouraging interaction and maintaining a conducive learning environment. The teacher plays a pivotal role in creating a classroom environment that strikes the right balance between promoting social interaction and maintaining a conducive learning atmosphere. Actively monitoring group activities is essential to ensure that noise levels remain within acceptable limits. When noise levels become disruptive, the teacher should not hesitate to intervene.

By proactively addressing noise issues and promoting effective communication, the teacher may create an environment that supports both social interaction and comprehension of the lesson. This ensures that students benefit from increased interaction while still being able to engage in meaningful learning activities without being overwhelmed by excessive noise.

3.5. Students’ insights into improving the use of digital badges in science education

The students’ insights provide valuable suggestions for enhancing the use of digital badges in gamification and promoting effective learning in the context of biology. One suggestion is to create additional badge types that cater to the diverse strengths and weaknesses of individual students. This approach recognizes that students possess different learning styles and preferences. By customizing badges to recognize and reinforce individual achievements, educators can encourage students to engage with the material in ways that align with their unique abilities. This not only enhances motivation but also supports a more inclusive and personalized learning experience.

Additionally, the students pointed out the need to incorporate rest periods between tasks during gamified activities. They recognized that participation in gamification can be mentally and physically demanding. Integrating regular breaks allows students to recharge and maintain their focus throughout the activities. These rest periods can help prevent fatigue and ensure that students can sustain their engagement and performance. This insight underscores the importance of balancing engagement with the well-being of students.

Furthermore, the students highlighted the importance of interventions to control noise during class activities. Increased social interaction is a positive outcome of gamification, but excessive noise can hinder comprehension and concentration. Teachers should implement strategies to manage and minimize noise levels while fostering a
collaborative and interactive learning environment. Clear guidelines, effective communication techniques, and structured group work can help create a balance between engagement and noise control, ensuring a productive classroom environment.

Moreover, the students stressed the need for interventions to support low-performing students in earning badges and keeping up with the lessons and activities. Digital badges can serve as motivators, but it is crucial to ensure that all students, regardless of their performance level, feel encouraged and supported in their learning journey. Providing additional resources, personalized assistance, and targeted feedback can help struggling students overcome challenges and experience success in earning badges.

In addition, the students identified an ultimate reward that holds meaning for them. While digital badges serve as immediate rewards and incentives, having a significant and meaningful ultimate reward can further enhance motivation and engagement. The ultimate reward should align with the learning goals and provide students with a sense of accomplishment and satisfaction for their efforts.

Lastly, the students recommended devising a method in which using digital badges as rewards would increase intrinsic motivation. Intrinsic motivation refers to the internal drive and enjoyment derived from the learning process itself. By designing badges and gamified activities that tap into students’ intrinsic motivation, educators can foster a genuine interest and passion for learning biology concepts. This could involve incorporating elements such as choice, autonomy, relevance, and personalization into the badge-earning process, allowing students to select topics and set learning goals. Teachers can make content relevant to real-life applications by connecting biology concepts to practical issues. Personalization and progress-tracking tools, such as progress bars, help students visualize their achievements. Collaboration and competition can be encouraged, fostering teamwork and friendly rivalries. Embedding a compelling narrative or story can immerse students in the learning journey, while immediate feedback and an emphasis on mastery rather than mere completion promote a growth mindset. By incorporating these strategies, teachers can create an engaging and motivating learning environment.

Key takeaways include the customization of badges to recognize diverse student strengths and learning styles, the importance of incorporating rest periods to prevent mental and physical fatigue during gamified activities, strategies to manage noise levels while fostering collaboration, interventions to support struggling students in badge-earning, the significance of meaningful ultimate rewards, and the enhancement of intrinsic motivation through badge design. Incorporating these insights into the design and implementation of gamified learning experiences may contribute to a more effective and engaging educational environment that caters to the diverse needs and motivations of students in the context of biology education.

**3.6. Implications of digital badges for learning biology concepts**

The analysis of students’ responses to the integration of digital badges within the context of learning science concepts in biology yields valuable insights into the
multifaceted impact of this innovative approach. These findings shed light on several key implications that warrant closer examination.

First and foremost, it becomes evident that digital badges exert a significant and positive influence on students’ class participation. Remarkably, students consistently expressed heightened excitement and motivation when digital badges were introduced into the learning environment. The prospect of earning badges engendered a competitive spirit that permeated the classroom, fostering an atmosphere teeming with enthusiasm and engagement (Fiş Erümit & Karakuş Yılmaz, 2022). Nevertheless, it is imperative to strike a judicious balance to mitigate the potential downsides associated with excessive noise and distractions that may impede comprehension. Therefore, teachers should proactively implement interventions aimed at managing noise levels, thus ensuring a conducive and productive learning environment. For instance, teachers can establish clear expectations for noise levels, use visual aids, and employ technology for real-time noise monitoring. Implementing group work guidelines and offering positive reinforcement through badge rewards can encourage students to maintain appropriate noise levels, creating an environment conducive to learning.

Second, the impact of digital badges extends to the realm of students’ behavioral patterns and time management skills. Respondents consistently reported a heightened dedication to their studies and assignments, driven by the desire to attain these digital accolades. In essence, digital badges serve as extrinsic motivators that propel students to allocate more time and effort to their academic pursuits, ultimately culminating in enhanced learning outcomes. However, it is paramount to consider the potential adverse effects on meticulousness and the quality of work. Striking a harmonious equilibrium between timely submissions and the cultivation of a profound understanding of the subject matter is pivotal when designing and awarding badges. To do this, teachers, for instance, may use assessment rubrics to define expectations, offer constructive feedback for improvement, and create a tiered badge system that rewards submission and content mastery. They may also encourage reflection, peer review, and ongoing formative assessment while periodically revising badge criteria to ensure alignment with learning objectives.

Furthermore, digital badges play a pivotal role in fostering social interaction and collaboration among students. The mere presence of badges significantly augments the allure of group activities, rendering them more enjoyable and engaging. These badges trigger a sense of competition and self-satisfaction that effectively catalyzes interaction and collaboration among students (Xu et al., 2022). The recognition and status conferred upon those who earn badges further serve to boost social interaction. Leveraging the potential of digital badges, educators can ingeniously mold an environment that vigorously promotes peer collaboration and open communication, both of which are indispensable components of effective learning. Teachers may employ targeted strategies to promote collaboration and communication among students. They may design badges to reward collaboration, organize challenges that require teamwork, and incorporate peer review processes. They may also establish mentorship programs, hold recognition ceremonies, and create collaborative learning spaces to reinforce the importance of
working together. These strategies leverage the intrinsic motivation of badges to foster peer interaction and enhance the learning experience.

Additionally, digital badges have emerged as potent tools for assessing and acknowledging students’ achievements and skills. These badges function as tangible, assessable artifacts that validate and accredit students’ acquired knowledge, skills, and accomplishments. They offer clear and compelling evidence of individual progress and growth in mastering science concepts in biology (Funa et al., 2021; Funa & Ricafort, 2019b). Moreover, digital badges can be effectively harnessed to track individual achievements and provide targeted feedback on specific areas of improvement. When thoughtfully aligned with learning objectives and competencies, educators can leverage badges as instruments to comprehensively assess students’ understanding and developmental trajectories.

Lastly, the insights gleaned from students’ recommendations underscore the importance of customization and meaningful rewards in the implementation of digital badges. Diversifying badge types to cater to students’ distinct strengths and weaknesses promotes inclusivity and cultivates personalized learning experiences. Furthermore, identifying a pinnacle reward that holds deep significance for students can serve as a potent catalyst for intrinsic motivation, further intensifying their engagement and unwavering commitment to the learning process. To promote inclusivity and personalized learning, teachers should diversify badge types to match individual strengths and weaknesses. They should create various badge categories, such as subject mastery or leadership, and offer different levels within each category to cater to diverse skill levels. Additionally, students should be allowed to propose their own badge ideas and to set personal milestones, empowering them to take ownership of their learning. Tailoring badge rewards toward students’ specific preferences and recognizing their achievements can serve as a potent motivator, enhancing their commitment to the learning process.

The implications drawn from students’ responses to the integration of digital badges in learning biology concepts emphasize their multifaceted potential as tools for enhancing participation, motivation, time management, social interaction, assessment, and personalized learning. These insights underscore the need for educators to carefully harness the power of digital badges to foster a dynamic and enriched learning environment that optimizes students’ educational experiences.

4. **CONCLUSIONS AND RECOMMENDATIONS**

This study has provided valuable insights into the potential benefits and challenges associated with the use of digital badges in the context of learning biology concepts. The findings underscore the multifaceted impact of digital badges on student engagement and learning outcomes. Digital badges have been shown to effectively enhance class participation, boost motivation, and encourage students to invest more time and effort in their studies. The competitive element introduced by badges has fostered an atmosphere of enthusiasm and engagement among students. However, while digital badges can be beneficial for high-performing students, they may have detrimental effects on low-performing students due to competition. Further, it is essential to strike a delicate
balance between the incentivization of timely submissions and the cultivation of a deep understanding of the subject matter. Moreover, the study highlights the profound role that digital badges play in promoting social interaction and collaboration among students. The recognition and sense of achievement associated with earning badges have driven students to interact and work together more effectively, contributing to a dynamic and enriching learning environment. Furthermore, digital badges serve as valuable tools for assessing and accrediting students’ achievements and skills, providing tangible evidence of their progress and growth in mastering biology concepts. The alignment of badges with learning objectives and competencies allows educators to make informed assessments of student understanding and development. In addition, this study emphasizes the importance of customization and meaningful rewards. A variety of badge types catering to individual strengths and weaknesses promotes inclusivity and fosters personalized learning experiences. Identifying an ultimate reward that resonates deeply with students enhances intrinsic motivation, thereby intensifying their commitment to the learning process. While these findings offer significant insights, it is essential to acknowledge the limitations of this study, including sample size restrictions and the specificity of digital badges and curriculum standards. Nonetheless, these limitations pave the way for future research endeavors that can further refine our understanding of how digital badges can be leveraged to optimize science education. For instance, future studies may involve a large number of participants with various characteristics, develop digital badges according to students’ needs and personalities, and explore relationships among the identified themes and variables.

REFERENCES


