International Journal of Engineering Trends and Technology
ISSN: 2231–5381 / https://doi.org/10.14445/22315381/IJETT-V71I9P212

Volume 71 Issue 9, 129-137, September 2023


*Original Article*

# Exploring the Impact of Gamification on Self-Directed Learning: A Study in an Online Learning Environment

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Received: 19 June 2023 Revised: 02 August 2023 Accepted: 08 August 2023 Published: 03 September 2023

***Abstract*** *- Efforts are ongoing in the field of education to integrate computational thinking skills into learning across different educational levels. The principles of constructivism derived from computational thinking provide guidance for the selection of appropriate learning mediums, such as game-based learning, which has gained popularity in education. Game-based learning strongly supports the development of computational thinking. Therefore, this research paper investigates the impact of a gamification strategy on learners' Self-Directed Learning (SDL) within an online learning environment. The study employed a quantitative research methodology, utilizing surveys and performance tests to collect data from 146 participants. The participants' SDL levels were assessed before and after the introduction of gamification elements, including points and badges, in the learning process of different programming languages. Descriptive statistics and inferential statistics were used to analyze the data, including mean values, standard deviations, and minimum and maximum scores. The Wilcoxon signed-rank test was conducted to assess the significance of the differences in SDL levels. The findings revealed that the learners' SDL levels significantly improved after experiencing the gamified learning environment. The mean values of SDL increased from M=3.52 before the intervention to M=4.63 after the intervention.*

***Keywords*** *- Computational thinking, Online learning environment, Gamification, Self-regulated learning.*

## 1. Introduction

The engagement and desire of students to study in the classroom is now one of the biggest issues lecturers encounter in the learning process. In order for students to remain focused on their studies and fully comprehend the content presented, lecturers must be able to reinvent their methods of instruction continuously. Lecturers also have the difficulty of how to increase the enjoyment of the learning environment [1]. The major objective is to improve learning performance by finding ways to make the classroom more enjoyable, motivate students to study, and promote engagement. To do this, lecturers employ various interactive learning technologies, including Kahoot! Quizzes, Wooclap, and others to enhance the learning environment. These resources may be divided into many categories, such as game-based learning (GBL), gamification techniques, and serial games. In a learning setting where students play utilizing non-digital or digital media to generate experiences that improve student understanding, gamification is the usage of game aspects in a non-gaming context [2]. In order for students to have an impact on their knowledge, suitable GBL media must include promising learning material in accordance with the curriculum.

As a result, game-based learning is often known as educational gaming since it offers pupils a gaming experience while still adhering to the curriculum or educational objectives. For instance, prior research has shown that the use of gamification boosts learning performance in terms of engagement, motivation, and curiosity. Additionally, gamification can enhance student learning. In order to apply this gamification, lecturers are essential. Lecturers value this method since it boosts student motivation by adding a fun aspect to the game.

Conversely, lecturers often believe that this idea cannot always be applied to all courses and that a lack of preparation time may prevent the use of gamification in education. Students respond differently to gamification. Some students are ecstatic about winning the game, while others are upset with the outcomes. Therefore, lecturers' participation and direction are crucial [3].

Gamification and game-based learning, two extremely popular mobile and technical trends that leverage game components to encourage desirable behaviors and generate corporate learning outcomes, might be implemented instead

of the current technology. This approach is based on constructivist learning, which emphasizes the importance of social interaction with peers and the environment for experiential learning. Gamification has been used in a number of earlier research [4]. There are two ways to use gamification in the Computer Information Systems course: chapter-based scenarios and scenario-based learning. In the first method, gamification is used to teach students comprehension based on the textbook and focuses on the course content's sub-sections. While role-playing is used to implement the second technique. Through the use of gamification, it was discovered that while only points are used to motivate students in scenario-based learning, the use of points and grades impacts student motivation in chapter-based scenarios. The freedom to choose the subject they wish to study first makes students pleased as well [5]. Gamification is used in the software testing course via quizzes and activities. The lecturers, followed by quizzes, will first explain the lecture content, and finally, exercises will be offered to the students. As a consequence of implementing gamification in this course, it was discovered that students who learn conventionally exhibit greater levels of engagement and perceived choice. Despite the fact that there is no difference in performance between the two groups of students, students who learn to employ the gamification strategy also get better post-test scores [6].

Contrarily, constructivism serves as the basis for computational thinking. Constructivism's teaching experience might be digital, physical, or even conceptual. According to the constructivism philosophy, the student is at the centre of learning. Experience has a direct role in influencing students' knowledge creation in the learning process, according to Piaget's hypothesis [7]. Additionally, Papert's learning framework demonstrates that knowledge will be added each time a student successfully completes a game's challenge; the use of technology led to increased thinking and a change in how students access understanding. This creates a connection between the game-based learning environment and CT. Both authors argue that the presence of GBL may promote computational thinking. Applying GBL to aid CT is more frequently found at the junior high school level, particularly at this time [2].

Computational thinking and GBL have been explored jointly in a number of research [1-3]. The use of GBL media to assist CT was found to be challenging for instructors, and there was ambiguity about learning results [2]. This is corroborated by [4], who claimed that it was challenging to determine the efficacy and dependability of game-based learning on students' academic achievement. Therefore, it is critical to comprehend how students react when presented with various learning conditions, according to [4]'s advice on learning. By drawing on students' opinions of how they learned to utilize GBL media to assist CT, this research will analyze the literature in detail.

Therefore, to meet student's educational needs and provide educational opportunities to students in places with different climatic characteristics and living circumstances, various teaching methodologies have emerged and have been applied in several educational systems across the globe. Because of this, gamification is becoming more and more popular in the world of online learning. Gamification approaches are techniques, processes, and frameworks that guide users in consistently deciding how to use game elements in a specific non-game context. Due to the term's popularity, promising outcomes, and rising interest in video games in general, particularly those used for educational reasons, the number of gamification approaches has increased in recent years. Another technique that is becoming popular in education is gamification. Gamified learning and education techniques have long been advocated for their potential benefits. There are several research on gamification that focus on gamified components. As a result, the purpose of this study is to investigate the impact of a gamification strategy on learners' Self-Directed Learning (SDL) within an online learning environment.

## 2. Related Work

Technology has become increasingly ingrained in our everyday lives as teachers use new electronic tools to support classroom learning. Within social networking sites created for educational purposes, students can collaborate on online projects [8], discuss lectures in online forums, view videos incorporated into an instructor's lecture notes, or use a combination of the aforementioned methods [6, 9]. Technology may improve learning in several ways, such as giving students immediate feedback, making more materials accessible, or enabling them to work on skills quickly and assess their understanding. For instance, this research [10] examines how technology is used by giving students tests using an online learning management system. Students may evaluate their understanding of the relevant study module in these self-paced online quizzes and get performance feedback. The authors contrasted two courses that employed these online tests, one of which gave students a gamified version of the tests. They argued that making these quizzes more game-like would improve the learning results. The theory of gamified learning was presented, and the authors based their presumptions and hypotheses on its premises. In particular, they stated that (a) passing an online quiz leads to improved learning outcomes, (b) students pass more online tests when the tests are made more fun, and (c) as a result, better learning outcomes result. Additionally, they looked at whether the benefits of gamification were affected by student achievement, which is known to be connected to students' ability to regulate their effort [11].

In a word, gamification incorporates game characteristics into surroundings that are not games. For instance, author [12] created a social networking site for education where students may debate educational concerns

and share educational experiences. They incorporated gamified online quizzes, which is particularly significant for the present research, in an effort to motivate students to understand the instructional materials from these quizzes. When students successfully completed these optional quizzes, they could earn badges and level up (i.e., badges and levelling up were game elements). After doing their research, they discovered that the majority of students valued the extra learning opportunity provided by gamified quizzes.

Another research [10-13] calls for organized endeavors to explore the influence of gamification on student learning. It serves as an example of how to employ technology and gamification within learning environments. For instance, they assumed that gamification would encourage students to complete the online quizzes. It was not obvious from their study, which did not compare the gamified and non-gamified quiz versions if gamification increased student interest or really improved learning. From there, we may categorise it as Self-Regulated learning, mastery learning, gamification, or quizzes from earlier times.

### *2.1. Self-Regulated Learning and LMS*

Self Regulated Learning (SRL) is a teaching strategy in which students voluntarily create learning objectives, keep track of their development, and evaluate their cognitive performance [14]. SRL is essential in learning environments like distant learning, e-learning, or online learning, where students lack direct human guidance or help. Although SRL is a built-in, innate ability [1], learners occasionally find it difficult or impossible to self-regulate their learning. Gamification is a potential way to sustain motivation, cognitive engagement, and metacognitive management—all of which are necessary for one to self-regulate their learning. When studying SRL, we may be interested in learning how SRL functions, why self-regulated learners learn well, and how a learner integrates SRL into his or her own online learning environment. When we learn, we apply our analytical and rational thinking to the things we absorb to gain knowledge, and we also reflect on our process of object analysis. Understanding knowledge involves two primary processes: a cognitive process that takes in information and a metacognitive process that controls the cognitive process [7]. Learning becomes more competent when a student becomes more mature in SRL and more conscious of and in control of their cognitive and metacognitive processes.

According to SRL models, an SRL process consists of the following three stages: creating a learning route, carrying out, overseeing, and regulating the learning process, and evaluating the learning process's efficacy [11]. Setting learning goals and objectives and organizing resources and activities to be used throughout the learning process are the first steps in the learning process for a self-regulated learner. After preparation, the learner continues the learning process by carrying out the learning plan to achieve the predetermined objectives. She/he also controls their learning by keeping track of how well they are learning and making adjustments to their cognitive activities, schedules, learning settings, and external assistance as necessary. In order to assess how successful the learning process has been, the self-regulated learner looks back on his or her learning journey after achieving end goals or the time limit. This includes but is not limited to, knowledge absorption, effectiveness, and efficiency of metacognitive and cognitive activities, as well as alternatives for better learning. The expansion of information and the expansion of the SRL ability itself are the outcomes of an SRL process [2].

While this is going on, Self-Directed Learning (SDL) is another approach in the field of education where students take charge and are responsible for their own learning [1]. SDL is necessary for learners to autonomously lead themselves in getting information in an online learning environment as well as to allow them to deepen their understanding to solve difficulties in their learning. These students often actively use learning resources, engage in learning activities, and define learning objectives. When compared to the traditional classroom method, course materials, information sharing, and assessment can be done anytime, anywhere online with the support of technology. Learners who exhibit more independent behaviour and a propensity for technological tools better understand the online learning environment and how to use it to meet the established learning goals [8, 15]. A combination of conventional and online learning techniques has been shown to be the most effective strategy for teaching and learning [13]. However, it is crucial to comprehend how to support the SDL dimension's motivation component in a fully online learning environment or even as a support in a blended learning environment [12].

### *2.2. Mastery Learning*

The cybersecurity awareness course proposed in this study [1] aims to provide students with cybersecurity information and a learning environment where they may develop the skills necessary to deal with cybersecurity problems in regular internet use. We design the course using a mastery learning strategy to fulfil that goal. According to [4], gamification may be a potent technique for encouraging mastery learning by giving students rapid feedback, incentives, and acknowledgment of their accomplishments. This may assist in boosting their interest and motivation and motivate them to keep studying until they have fully grasped the subject. Through the use of branching scenarios or simulations, where learners are presented with various scenarios or situations and must make decisions based on their understanding of the content, mastery learning can be incorporated into gamification. With this method, students can practise and apply their knowledge in a real-world situation while also getting immediate feedback on how they are doing [3].

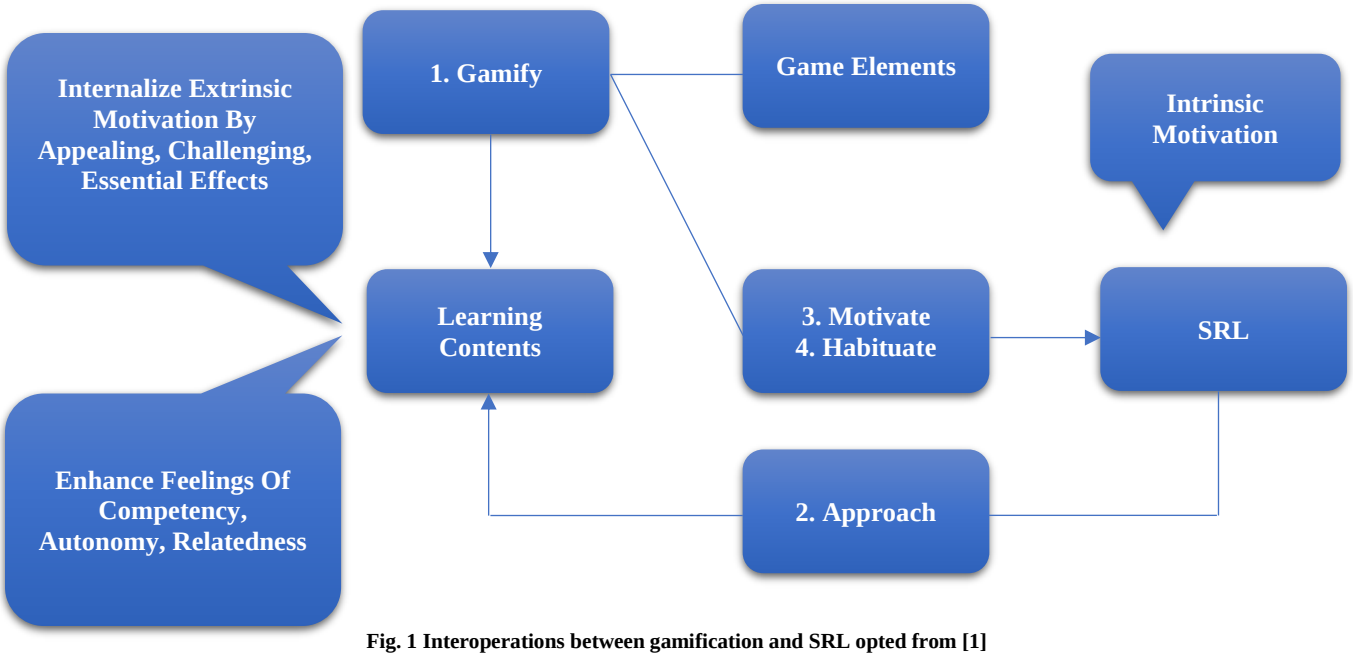


**Fig. 1 Interoperations between gamification and SRL opted from [1]**

Another way that mastery learning can be integrated into gamification is through the use of adaptive learning technologies, which can personalize the learning experience for each individual learner based on their level of proficiency and progress [12]. This approach allows learners to work at their own pace and receive targeted feedback and support to help them master the material.

### *2.3. Gamification*

The use of game mechanics or game components in non-gaming situations is known as gamification. Empirical research demonstrates that gamification in educational and training environments aids students in longer-lasting and deeper information retention [10]. Three advantages of gamification for learners include motivation, mental relaxation, and habit reinforcement.

Figure 1 shows how SRL, game components, and learning materials work together to provide the aforementioned advantages. When students self-regulate their learning, game elements serve as the stimuli that encourage motivation, autonomy, and learning progress. A student might be motivated in both intrinsic and extrinsic ways. Knowledge expansion, skill improvement in a particular area of competence, and an enlightened and expanded mind may all be intrinsic incentives. Extrinsic motives might include praise from peers for excellent work, prizes for completing difficult exercises, and points gained for each step forward. Self-regulated learners are those who are intrinsically motivated to study [1].

According to [5], game-based learning has a lot of promise, especially in higher education. Author [6] made the finding that an efficient method for improving academic performance may include interactive games, which can play a significant part in cognitive growth. Author [10] asserts that playing video games directly affects a person's cognitive skills, motivating aspirations, and emotional growth. According to their results, it is vital to fully use technology tools as they develop in order to gamify teachings in the educational process. On the other hand, there are other elements to consider before game-based learning is implemented, such as the cost that will arise and the time it will take to construct the games. However, game-based learning is difficult to integrate into the teaching and learning environment due to its drawbacks, such as the expense of development and the length of time required to create the right games. Therefore, rather than developing a brand-new game from scratch for the education sector, the more practical and appropriate approach known as gamification learning environments with the infusion of game elements like points, scores, leaderboards, ranks, etc., seems more practicable [11].

### *2.4. Quizzes*

Games should ideally promote excitement, engagement, competition, and chances for social interaction and self-expression in a relaxed setting. Investigating the possibilities of gamified educational software to simplify teaching and improve learning outcomes is interesting. Author [12] stated that "Gamification aims to increase participation and motivate users through the use of game elements such as points, leaderboards, and immediate feedback, among other things." "Quizizz is a fun multiplayer game platform or application classroom activity for quiz-games," according to [13], "in which students become the controller of their pace of game classroom activity." Leaderboards, time limitations, points, and social connections are just a few of the

gamification aspects that Quizizz has included to increase user engagement, motivation, and a feeling of empowerment in finishing the job at hand.

The use of Quizizz in education has been the subject of several research, and the findings are encouraging. In order to include enjoyable learning, [16] looked at the usage of Quizizz in an accounting classroom. The author of this research claims that the students like Quizizz and that adding enjoyable and interactive features helps keep their interest. The leaderboard, motivating them to compete and aim for better performance, was named the students' favourite Quizizz feature. Author [17] research looked into Quizizz as a game-based learning tool in an Arabic classroom. The study's findings indicated that using Quizizz in Arabic classes is highly likely beneficial since it has been shown to increase students' attention spans and levels of engagement in the subject matter.

Author [18] conducted a comparative study comparing students' perceptions of two online educational quizzes, dubbed "Kahoot!" and "Quizizz." The study's results revealed that students thought Quizizz was a superior option to Kahoot for web-app online quizzes [19]. Quizizz can increase interest and motivation, but insufficient conclusive studies convince us that it is a useful and appropriate instrument for language learning and training. Examining Quizizz's effects is necessary to support the argument that it is a helpful and successful tool for enhancing language teaching and learning, offering insightful information to all parties involved in the education sector [20].

## 3. Methodology

As we already mentioned, this study used a quantitative research technique to collect data, with a survey questionnaire serving as the major data-gathering tool. A before and post-assessment test was carried out to measure the influence of gamification intervention on learners' academic achievement. A survey was also conducted before and after the participants' participation in gamified learning to measure their degree of self-directed learning. The gathered data was analyzed to establish the correlations between the variables.

### *3.1. Research Framework*

We set different phases in our research framework. We started the initial phase, and during the initial phase of the study, the problem discovery and problem understanding stages were undertaken. This involved conducting a preliminary investigation by examining previous literature on gamification elements, self-directed learning issues, and online learning environments, which served as a basis for understanding the research problem.

Moving on to the second phase, the course learning environment was designed. In this stage, research instruments were developed to collect data and were subjected to a pilot study for testing. These instruments were constructed and selected based on the findings from the literature review conducted in the first phase. Additionally, the gamification learning environment was designed and created during this phase.

In the third phase, a pre-experimental design known as the one-group pre-test-post-test design was employed. This design was implemented on all computer science learners enrolled in the Programming Language course. The course was delivered through an online learning mode, and the teaching and learning activities spanned a period of four weeks. Data were collected from the e-learning system utilized for the course, including performance test scores and quiz scores. Furthermore, a survey questionnaire was administered to the experimental group both before and after the gamification learning intervention. The collected data were analyzed using descriptive and inferential statistics.

The sample for this study consisted of third-year undergraduate learners majoring in computer science who were enrolled in the Programming Language course at the university. The sample size comprised 146 computer science learners and was selected using a purposive sampling technique. This group of learners and the specific subject were chosen because the Programming Language course necessitated extensive practice. Yet, many learners exhibited low motivation when it came to engaging in non-graded, self-directed learning activities.

### *3.2. Learning Environment Design*

In this proposed model, multiple machine learning models, namely the K-nearest neighbor (KNN) classifier, logistic regression, decision tree, and multilayer perceptron (MLP), were employed for the automatic directory categorization of test cases based on their descriptions. The feature representation used was the Bag-of-Words (BoW) approach, which was applied to all the classifiers. The research's primary objective was to compare these models' performance in accurately categorizing test cases and reducing manual effort. For the KNN model, the study utilized the optimal parameters obtained from the BoW or TF-IDF vector representations. The scikit-learn library in Python was employed to develop the model. In the BoW approach, the Minkowski metric was employed to calculate the distance between a vector and other vectors in the training dataset. Notably, the study found that the cosine distance was unnecessary in BoW since the document sizes were nearly equal. On the other hand, in the TF-IDF approach, the cosine metric was used to compare the distance of a vector to others in the training dataset, as size normalization is required when computing the cosine distance.

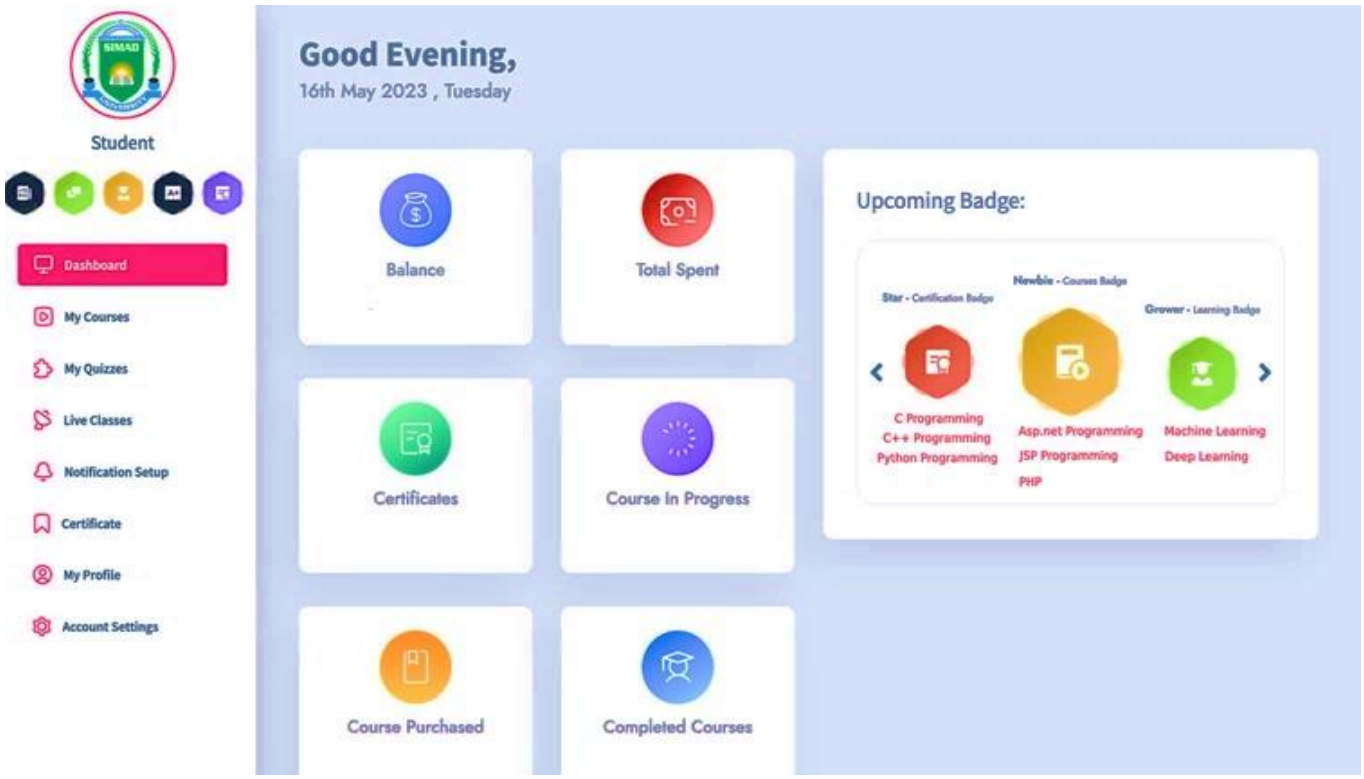


**Fig. 2 Implemented LMS design**

The learners participated in an online learning environment with gamification integration in the Programming Language Course, undergoing the learning process for approximately four months. Their progress was closely monitored as they completed Topics 4 and 5, which encompassed C programming (Parts 1 and 2), C++ programming (Parts 3 and 4), and Python programming (Parts 5 and 6). Additionally, they covered topics such as ASP.net, JSP, and PHP as beginners and delved into Machine Learning and Deep Learning as they advanced in their learning journey. These topics were selected based on identifying areas where learners typically struggled and exhibited low motivation and engagement during the course.

The InfixLMS version 2 platform was utilized to introduce gamification elements. Through this platform, instructors uploaded course materials such as notes, videos, assignments, and quizzes, providing learners with accessible and comprehensive content—the formative assessments, including quizzes and assignments, incorporated gamification elements as part of this research. To earn specific badges, learners were required to complete all module components and course assessments within the LMS. These badges were prominently displayed in the learner's user profile within the course section, as depicted in Figure 2. Quiz scores extracted from the LMS were utilized to analyse the rankings on the leaderboard. The ranking placements were determined based on the highest scores obtained, with priority given to the earliest submissions.

Meanwhile, this study used two instruments to measure the effects of a gamified learning environment on Self-Directed Learning (SDL): a performance test and a questionnaire. The performance test was designed to assess learners' knowledge of the course content before and after engaging with the gamified learning environment. The questionnaire was administered to the sample group during both the pre-test and post-test stages to measure their SDL aptitude.

The questionnaire consisted of five-point Likert scale statements, where respondents indicated their level of agreement on a scale of 1 to 5, with 5 representing "strongly agree" (SA), 4 denoting "agree" (A), 3 indicating "undecided" (U), 2 reflecting "disagree" (D), and 1 representing "strongly disagree" (SD). The SDL questions were adapted from a previous study [5], specifically from the Self-Directed Learning Aptitude Scale (SDLAS), which comprised 26 Likert-scale questions. To ensure the suitability and effectiveness of the questionnaire, a pilot study was conducted involving 40 learners who had previously taken the same course. The reliability test yielded a total coefficient value of 0.94 for the SDL instrument, indicating high reliability.

## 4. Results and Discussions

The study's findings encompass a comprehensive examination of the gamification components employed, followed by an elucidation of inferential statistics concerning

learners' Self-Directed Learning (SDL) and descriptive statistics about their gamification experience (GE), encompassing measures of central tendency and frequencies. Furthermore, the association between variables was examined and expounded upon. In conclusion, the quantitative data analysis and interpretation findings were succinctly summarized.

### *4.1. Results*

Regarding the level of self-directed learning among learners within the gamification learning environment, an examination was conducted on the mean scores for Self-Directed Learning (SDL) before and after incorporating the gamification strategy, encompassing all participants (N=146). It is worth noting that no negative scores were observed in the differences in the collected data. Before implementing the gamification strategy, the average SDL score varied from M=2.14 (minimum) to M=4.89 (maximum).

However, subsequent to the introduction of the gamification strategy in the online learning setting, the average SDL scores ranged from M=3.85 (minimum) to M=5.40 (maximum).

**Table 1. Detailed statistic for sdl(before) and sdl(after)**

| SDL | No | Mean | St. Deviation | Min | Max |
|---|---|---|---|---|---|
| Before | 146 | 3.52 | 0.84 | 2.14 | 4.89 |
| After | 146 | 4.63 | 0.78 | 3.85 | 5.40 |

The Wilcoxon signed-rank test was conducted to analyze the difference in participants' SDL levels before and after the introduction of the gamification strategy. The steps involved calculating the differences between SDL scores, arranging them in ascending order, and assigning ranks to each difference. The sum of positive ranks (SP) and negative ranks (SN) was calculated, and the test statistic (T) was determined using the smaller SP and SN.

In this study, the obtained test statistic (z) was -4.706, and the corresponding p-value was 0.000, which is less than the significance level (α) of 0.05. These findings indicate a significant difference between participants' SDL levels before and after implementing the gamification strategy in the learning environment. Furthermore, the mean rank for SDL after the gamified learning environment was 15, while the mean rank for SDL before the gamification strategy was 0.0. This indicates that participants' SDL levels were rated higher after experiencing the gamified learning environment.

Here is a table presenting the results of the Wilcoxon signed-rank test for participants' Self-Directed Learning (SDL) levels before and after the gamification strategy in the learning environment:

**Table 2. Wilcoxon signed ranks test of participants' SDL**

| SDL | Negative rank | Positive Rank | Ties | Mean Rank |
|---|---|---|---|---|
| After Before | 0 | 146 | 0 | 73.5 |

In this table, each participant is assigned a rank based on their SDL level before and after the gamification strategy. The "Difference" column represents the difference between the ranks of SDL levels (Rank [After] - Rank [Before]), and the "Absolute Difference" column shows the absolute value of the differences. These absolute differences are used to calculate the test statistic for the Wilcoxon signed-rank test.

**Table 3. Wilcoxon signed ranks test of participants' SDL**

| SDL | Z | Asym. Sig(2-tailed) |
|---|---|---|
| After Before | 0 | 146 |

The table provided in the previous response illustrates the results of the Wilcoxon signed-rank test. It includes the ranks assigned to each participant based on their SDL levels before and after the gamification strategy and the differences and absolute differences between the ranks. These findings collectively support the conclusion that the gamification strategy had a significant impact on enhancing participants' SDL levels in the learning environment.

### *4.2. Discussions*

According to our findings, implementing the gamification strategy in the learning environment led to an enhancement in learners' Self-directed Learning (SDL) levels. Prior to the intervention, the mean SDL values were recorded at M=3.59, whereas after the intervention, the mean values increased to M=4.22, indicating an overall improvement in SDL among the learners.

This gamification-based learning environment places emphasis on SDL, highlighting learners' responsibility for their own learning process in the online setting. Upon completing the gamification strategy, 94% of learners achieved a high level of SDL, while 3.4% achieved a medium level.

Within the gamified learning environment, learners were granted adequate control over their learning process through various gamification activities and resources accessible on the e-learning platform. They were empowered to determine their learning pace and select appropriate approaches to acquire knowledge within this gamified context.

The facilitation and guidance provided by educators in aligning learners with their goals proved successful. Introducing a reward structure, such as the Top 5 Winners

Reward, within the gamification environment heightened learners' motivation. When learners perceived the learning goals as achievable and relevant to their objectives, they were motivated to engage in the gamified learning process actively. Consequently, their motivation increased, effective teaching techniques were recognized, and positive attitudes towards science teaching and scientific topics were fostered.

Moreover, the introduction of gamification elements and clear communication of rules, conditions, and rewards aligned with the learning goals incentivized learners to participate actively in the online learning environment and sustain their learning activities. This aligns with previous research indicating that gamification environments promote self-directedness among learners and enhance their learning performance.

However, it is important to acknowledge that despite the improvement in motivation and performance resulting from the gamification strategy, some learners may still find the subject challenging. Nevertheless, the strategy effectively enhanced their performance and motivation towards the discipline, as supported by existing research studies.

## 5. Conclusion

In conclusion, this study investigated the impact of a gamification strategy on a learner's SDL within an OLE. The findings demonstrated that the introduction of gamification elements, such as points and badges, led to an improvement in learners' SDL levels. The mean values of SDL before the gamification strategy were relatively lower, but after the intervention, they significantly increased, indicating a positive effect of the gamified learning environment on learners' SDL. The gamification strategy provided learners with control over their learning process and allowed them to set their own goals and objectives.

Educators acted as facilitators, guiding learners and keeping them on track with their learning goals. The reward structure implemented within the gamified environment effectively increased learners' motivation to engage in the learning process. The results also revealed a correlation between the gamification elements and learners' motivation, teaching effectiveness, and positive attitudes toward science teaching and scientific topics. Learners demonstrated an increased level of motivation and a recognition of effective teaching techniques within the gamified learning environment.

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