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A COMPARISON OF THE EFFECTS OF INDIVIDUAL AND TEAM PARTICIPATION IN GAMIFIED LESSONS ON ASSESSMENT PERFORMANCE

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Abstract

Gamification has been used by teachers as a tool to review basic concepts learnt by students in traditional as well as in flipped classrooms. This technology offers students the ability to participate either individually or in teams to solve problems within the given time constraints with points awarded or deducted for the answers provided, and the chance to finish the game on top of a leaderboard, which provides motivation for students to actively engage with the game. This research aims to compare the effects of engaging in gamified lessons individually and in pairs on students' summative assessment scores. An experiment was conducted in which two groups of students used Quizizz, an online lesson gamification tool, with one group participating in online quiz games on 3 different topics individually, whilst the other group participated in pairs. Both groups were then provided the same summative assessment on these topics to attempt and the results of this were analyzed and compared for both groups to establish the effects of individual versus paired participation in gamified lessons. Data on average points scored and time taken per question for both groups was analyzed using MS Excel, along with graphical comparisons of performances between male and female students and comparisons of scores in the formative and summative assessments taken. This research found that the group of students participating in pairs in the online formative assessment performed better than the group of students participating individually but there was no significant difference between both groups in the summative assessment.

Index Terms: Gamification, Formative Assessment, Summative Assessment, Learning Objectives, Individual Participation, Team Participation, Education.

1. INTRODUCTION

Gamification is defined as the utilization of elements of game design in what are traditionally considered as non-game contexts [1]. Elsewhere, gamification has been

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defined as "...changing the way of thinking and using some 'gaming rules' in order to increase the interest of learners and to solve problems." This process occurs by adapting certain game elements to processes and environments which are not usually associated with gaming, such as classroom learning [2]. Another definition of gamification by Marczewski is "the application of gaming metaphors to real life tasks to influence behavior, improve motivation and enhance engagement" [3].

Gamification involves changing a conventional non-game process using a game or its elements. It can be used to increase motivation in people working together in a team by engaging them and providing them opportunities to collaborate with each other to reach a common goal. Gamification can thus also be defined as a set of activities and processes to solve problems by leveraging characteristic game elements or components [4].

Gamification has been applied in various areas, including the education, business and fitness domains. Despite Piaget's support for games as tools for children to engage in meaningful interactions with and learn from their environments, it was not until recently that research on games in education was seriously looked into. Indeed, as of 2013, only 26% of scientific publications in gamification discussed its practical application in the domain of education with the first important framework of gamification published only 2 years earlier by Deterding [7].

2. LITERATURE REVIEW

2.1 Elements of Gamification

Gamification has some similarity to games, as seen previously, but they are not exactly the same. The term gamification was first used by Nick Pelling in 2002, but the term saw more widespread usage from 2010 onwards. As the term suggests, gamification is not necessarily creating a game per se, but it involves the transfer of some of the positive characteristics or elements of a game to something that is not a game, thus gamifying the process. Those positive characteristics of a game that are often loosely described as "fun" and have the effect of engaging game players in the activity are included in this process of gamification. The fun in gameplay is engineered by the four building blocks, or defining characteristics, of a game which include one or more goals to be achieved, a system of rules to be abided by, a feedback system to improve performance, and voluntary engagement of the participants from the target group [5].

According to available research online, certain underlying dynamics and concepts found in game design have shown evidence to be successful on more occasions than others when applied to learning environments. These include providing the participants with the freedom to fail, providing timely feedback so that the students learn from their mistakes, progression to make student learning more evident, and storytelling by placing the students at the center of the narrative [6].

Table 1 summarizes the framework which categorizes game design elements into two categories, namely design principles and mechanics, with examples of each [7].

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According to a comprehensive review of literature from 2014 to 2019, the most popular game mechanics amongst students of programming courses in higher education settings were leaderboards, followed by points, badges, and levels, which indicates that students are motivated by healthy competition with their peers, progress of their characters in the storyline of the game, and their achievements [8]. Leaderboards help participants in setting and working towards higher and more difficult goals, thus improving motivation towards the achievement of such goals [9].

Design Principles	Mechanics
Social engagement, including competition and collaboration	Scoring system
Freedom to choose	Levels to complete
Freedom to fail	Badges to achieve
Rapid feedback	Leaderboards
Challenges	Currency for trades and purchases
Customization	Countdown timer
Chances to unlock new content	Progress bars

An empirical study of nearly 200 students across 2 schools participating in an online physics lesson showed that the same three game elements, namely leaderboards, points, and badges, had a positive impact not only on the perceived usability of the gamification tool but also on student engagement with the learning activity [10].

Robson et al introduced another framework that involves not only the way in which the game works but also how the player or user interacts with it to make a complete gamified experience. In ideal gamified systems, player's emotions and the resulting dynamics should give shape to the mechanics of the game and vice versa [11]..

2.2 Gamification in Education

Despite the rising popularity of gamification in education, many teachers and professors, especially in the higher education sector, have either not kept themselves informed of the concept of implementing serious games in the teaching and learning process, are not up-to-date with the latest tools and technologies, or do not have the time to integrate these methods into a tightly packed calendar of teaching activities. The attitude towards future adoption of gamification, however, is positive, according to a survey conducted of software engineering professors in Brazil [12].

2.2.1 Game adaptation to player profiles

Research into gamification in education has emphasized the importance of adapting game elements to player types based on their profiles. For example, the Gamification User Types Hexad is a model created by Marczewski to help game designers understand the types of people that use systems involving gamification [3]. This model represents the different kinds of motivation and methods by which users interact with a game. However, each user or player usually exhibits one or more of the various types of motivation to varying degrees, so a straightforward classification of a player into a single category is not feasible. Marczewski lists the user types as Socializers (motivated by relationships), Free Spirits (motivated by freedom to explore), Achievers (motivated by challenges),

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Philanthropists (motivated by altruism), Players (motivated by rewards), and Disruptors (motivated by change) [13].

Keeping these player profiles in mind, research has been conducted on how the level of game element adaptation to player profile information affects the performance of learners in gamified lessons. In one such item of research, learners were presented with a different game element from an online tool, to be used for one month, based on their motivation type. It was found that learners who had game elements that were a better fit to their motivation type showed significant differences in how they engaged with the online tool, how motivated they were to keep learning, and how well they performed in quizzes as compared to learners who had been presented with randomly assigned game elements. They used learner participation rates in the online activities to measure engagement and motivation levels [14].

In another experiment, the researchers divided learners into three different groups: one group received game elements adapted to their player type, one group were assigned counter-adapted game elements, and the third group were given random game elements. Learners were given the autonomy to benefit from the learning environment as they wished over the course of three weeks. The authors deduced that learners who were assigned the adapted game elements spent more time using the learning tool compared to those with the counter-adapted elements [15]. From another study of the adaptation of game elements to player profiles, it was found that learners who utilized game elements adapted to their user type showed a higher rate of course completion than those who interacted with random game elements. This effect was also observed with learners' motivation which was measured using a questionnaire [16].

Despite the positive implications of adapting game elements to user Hexad profiles, care needs to be taken in this process, since studies have shown that the use of counter-adapted game elements can result in lower performance than the that of students not exposed to gamified lessons [17]. However, better performance has been shown to be correlated to better adaptation of game elements in gamified lessons to player types and Hexad profiles, as numerous studies and experiments have shown which have been discussed earlier [18].

2.3 Benefits and Drawbacks of Gamification

Many businesses have embraced gamification to design incentive systems, including mobile apps that engage employees via rewards, leaderboards and badges. The gamification of education is gaining more support from members of the education profession and researchers who recognize that games enhance productivity and develop creativity among learners. Gamification primarily adds value through increased, voluntary and enjoyable engagement. This engagement assists in bringing in new users and can result in a culture which encourages multiple instances of usage and longer usage duration from returning users. Once attracted by the allure of the game, the amount of time spent gaining brand awareness increases, which in turn increases the chance of users purchasing the brand's products which could further lead to brand loyalty [5].

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Efforts to integrate the elements of gamification into higher education courses available online could result in existing mechanisms of motivation being expanded for certain types of students. This process brings into focus a connection between long-term aims and short-term motivation to complete tasks, which often is lacking in self-paced online learning environments. Separation and weak feedback loops between the student and the professor can be overcome by creating a system for continuous reward through the student scoring points to attain higher levels for their game character during their online coursework. While a task may appear to be difficult, it becomes a source of gratification when the deadlines of daily assignments are coupled with the desire to help the game character thrive and progress in the game context overlaid onto the learning process. The creative thinking skills of the student to survive in the gaming environment can then result in increased success in attaining higher grades, which can improve satisfaction with their teachers and the course overall [19]. For example, students using an online quiz game platform such as Quizizz to attempt a mid-semester examination in an information management course in Indonesia reported through a survey that the major reason why two-thirds of them preferred the gamified assessment over traditional testing methods is because it is ‘fun’ and ‘challenging’ [20].

Many in the education profession are hopeful that gamification will not only increase students’ motivation to learn but also allow participation in schoolwork to become more effective and meaningful. Critics, however, argue that gamification bombards the learning process with distractions, adds the unneeded stress of competing with fellow students and fails to take into consideration the special educational needs of certain students. The value added by gamification to the learning process, and education in general, remains controversial, despite an increasing number of experimental studies and reviews of literature that may inform this controversy [7].

In his review article, Ekici noted that whilst most empirical research from 2016 to 2019 agreed that gamification has had positive impacts, especially in the context of flipped classrooms, thus giving rise to student-centered learning in the process, a few papers have reported no impact on assessment scores. In technical subjects such as mathematics and physics, improvements in test scores have been noted but in subjects relying on more verbal answers to questions, for example humanities subjects, there is little impact on students’ performance in summative assessments [21]. Other reviews of literature have also pointed out statistically insignificant differences in the performance of students engaging in gamified lessons and students in traditional classroom settings [22].

In summary, studies have shown that gamification in education is beneficial to students, especially those undertaking online courses. It provides motivation, immediate feedback and satisfaction with the learning experience. However, if only the surface elements of awarding points and badges and leveling up game characters are implemented without a proper game design, gamification can lead to distraction and less engagement with the learning materials and content. If gamification is implemented properly in the education context, on the other hand, this can ultimately result in higher passing rates amongst students, and the overall learning experience and student attainment can be further

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enhanced if the students' player profiles are studied, and the appropriate game elements assigned to each student according to their intrinsic motivations.

In all such studies of gamification and its impact in the education context, there has so far been no comparison of how this impacts learners who engage with online learning tools individually and students who work in pairs or larger groups to solve problems in a gamified learning environment. Reviews of literature and empirical studies have shown how game elements can be used to foster cooperation between team members [23], which can be achieved by using either a collective approach in which team members have shared goals and interdependent roles, or a hybrid approach which provides team members individualistic motivations to help achieve team goals [24], but a direct comparison with how collective engagement affects student achievement as compared to individual participation in online quiz games has not been carried out. This study aims to make this comparison between two groups of students of similar academic capabilities being assessed using the same online learning tool in gamified formative assessments and how engaging individually versus in pairs affects future summative assessment attainment.

2.4 Online Quiz Game Platforms

There are multiple online platforms which allow teachers to create and host quiz games with their students. Table 2 provides a comparison of some of the more popular online quiz game platforms that are widely available for teachers and students to benefit from, namely Kahoot!, Gimkit, Quizlet, and Quizizz, one of which will be used in this research.

Table 2: Summary of four online gamification tools

Online Quiz Game Tool	Advantages	Disadvantages
Kahoot!	Most widely used gamification tool Wide range of pre-made quizzes available Easy-to-use for both students and teachers	All students get the same questions at the same time, so testing requires vigilance. Time per question may be too short for students with special needs.
Gimkit	Integrated storyline in each quiz game with the student playing a central character role Ability to use points to purchase power-ups	Limited features with a free account Limited variety of quizzes available
Quizlet	Can create flashcards from content uploaded by the teacher Can use flashcard content further to generate engaging quizzes	Minimum group size required for team participation in quizzes, so individual participation not possible
Quizizz	Student-paced quizzes Live leaderboard with points and rankings as students progress	Feedback by the teacher can only be given at the end of the entire quiz due to random order of questions for each student

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3. METHODOLOGY

3.1 Research Design

This research aims to compare the performance of two groups of students in online gamified formative assessments in which one group participates individually and the other group participates in pairs and to determine the impact of the mode of participation in the online gamified formative assessments on summative assessment scores. Since meeting these research objectives requires collecting quantitative data to make accurate predictions about summative assessment performance based on how students perform, either as individuals or in pairs, in several formative assessments, the descriptive research design is the most suitable for this research, because this type of research design is usually utilized to identify patterns in a population or sample, which in this case were the students participating in this experiment.

3.2 Sampling and Population

Both groups of students were part of existing classes of the same year level, Year 10, at a British curriculum school in Dubai, United Arab Emirates during the 2023-24 academic year. They were studying the Cambridge International GCSE Chemistry syllabus from the same teacher since August 2023. The two groups each had a roughly equal number of students in total and similar ratios of male to female students of 50% male students to 50% female students in Group 1, which attempted the online formative assessments individually, and 56% male students to 44% female students in Group 2, which attempted the online formative assessments in pairs. Both groups also had a similar performance in the previous term, Term 1, from August to December 2023; Group 1, which participated in the online quiz games as individuals, had an average Term 1 score (combining all summative assessments and the end-of-term examination) of 56%, whilst Group 2, which participated in the online gamified formative assessments in pairs, had an average Term 1 score of 59%. This division of students allowed for a fair comparison of the effects of individual and paired participation in online gamified formative assessments on summative assessment scores.

The selection of the student groups for participation in this experiment was based on the fact that all of them were aware of how to use the selected online gamification tool (discussed below) and did not require further training on its use. A purposive sampling technique, therefore, was used to select the sample of students which was then divided into 2 groups for this experiment.

The 2 groups of students were existing sets of the Year 10 Sciences batch for the 2023-24 academic year in their school, so no changes needed to be made to divide the students in a different manner. It helped that the 2 groups had similar male-to-female student ratios and similar performances in the previous term before the experiment was conducted, as detailed above. Therefore, an element of convenience sampling was also utilized in the formation of the 2 groups for this study. The pairing of students in one of the 2 groups was carried out based on the teacher’s judgment to keep the combined capabilities of all pairings roughly equal.

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3.3 Instrumentation

3.3.1 Choice of Online Gamification Tool

The platform used to conduct the timed online quiz was Quizizz. After a detailed description and comparison of four well-known online quiz game platforms given previously, the reasons for selecting Quizizz as the platform of choice for this experiment include the familiarity of the students with the platform, since they have been using Quizizz for online gamified formative assessments previously and need no additional training, the ease of use that Quizizz provides due to its simple interface and overall accessibility without the need for students to have accounts on the website, and the availability of more features for the teacher to create and host live quiz games online using a basic educator account, which the school involved in this research has already provided to all teachers.

3.3.2 Online Feedback Survey

Once the online quiz games were conducted, an online feedback survey was administered via Microsoft Forms for the students to complete. In this survey, the students' perceptions of their preparedness for the online gamified formative assessments, the difficulty level of the questions asked, and their experience overall were gathered using a 5-point scale. Recommendations were also gathered from the students on how to conduct future online gamified formative assessments in the future by asking them to select at most two options from a given list of suggestions. The questions and the insights gained from each are detailed under the Discussion section.

3.4 Ethical Considerations

To ensure that all students' personal data remains private and confidential within the context of this research, the data in the spreadsheets downloaded from the Quizizz platform after the online quiz games had been conducted were anonymised, which means that all data that could be used to identify individual students, such as first and last names, were removed before any analysis of the data was carried out. Any insights that were derived from the data were averages, which rely not on any individual record but on the aggregate of data collected.

After the online quiz games were completed, an online feedback survey was conducted that required students to answer questions on their experience and suggest improvements to the method adopted for conducting online formative assessments. In the online form shared with the students, a statement in the beginning made it clear that the data used from this form will be used for academic research purposes, therefore, by filling the form, the students provided their informed consent for the usage of their responses. The form had been kept anonymous with no recording of students' names so that only their responses could be used to inform future approaches to online formative assessment based on the submitted feedback.

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3.5 Data Collection and Analysis

3.5.1 Data Collection Using the Online Gamification Tool

In this experiment, there were 3 online gamified formative assessments that were conducted for both groups of students on the same 3 topics over the course of a month. The 3 topics, in line with the Cambridge International GCSE Chemistry syllabus being taught to both groups of Year 10 students, were as follows:

- Topic 1: Elements, Compounds, and Mixtures
- Topic 2: Reactivity Series
- Topic 3: Extraction of Metals

Once the online quiz game sessions hosted live in the classroom are complete, the teacher is able to access and download spreadsheets containing information about the online formative assessments and each student's attempts which includes the numbers of students who attempted a particular question in a quiz either correctly or incorrectly, the average time taken and the average percentage accuracy for each question, the time taken by each individual or pair of students on each question and the answer choices selected by them, and a list of participants ranked according to the points they gained.

This data is also available on the Quizizz online dashboard for teachers, which makes it easier to navigate to important data and highlight actionable insights for collective and individually targeted formative feedback, but the downloadable spreadsheet makes it easier for teachers to analyse data regarding each student's attempt and the average performance of the class in order to make fair comparisons between groups of students in a more convenient manner.

3.5.2 Experimental Fairness Considerations

Both groups attempted the quizzes online on the same 3 topics as listed previously. A set of 10 multiple-choice questions, each with 4 options to choose from with one correct answer, was provided in each online quiz game. Due to the varying difficulty level of the questions in the quiz, different time limits were given for each question, ranging from 20 seconds for simpler questions to 30 seconds for more complex questions. The students could take more time to answer a question if needed, since the quiz was student-paced, but bonus points would be awarded for answering questions accurately in less time. A total of 15 minutes was provided as the maximum time allowed for each of the 3 online quiz games conducted.

All questions were selected from past papers of the Cambridge International GCSE Chemistry syllabus, available on the Cambridge School Support Hub website which the teachers at schools teaching the Cambridge curriculum have access to. A mix of questions were selected which included questions with diagrams, tables of data, and real-life application contexts, and a reasonable variation in the difficulty level of the questions was ensured by the teacher's judgment from their teaching experience. To ensure that testing was carried out in a fair manner, the questions and answer options were shuffled randomly by the online quiz game platform and the correct answer to each question was

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not revealed immediately after the question was attempted but at the end when the entire quiz was completed. To ensure that the students attempted the online quiz game without too many distractions, the quiz was hosted using Test Mode. A leaderboard was kept visible to show the progress of the students through the quiz. However, since the correct answers were revealed to the students only at the end of the quiz attempt, the progress in terms of points scored could not be shown whilst the quiz game was still taking place. A fixed number of points were allocated to each question to be awarded to the students for selecting the correct answer choice, with bonus points awarded for answering the questions as quickly as possible. This system allowed for the students to take a serious formative assessment online via a quiz game platform whilst keeping essential gamification elements intact to boost the motivation of the students to perform better during the course of the online quiz game.

4. RESULTS

One of the key features of the Quizizz online quiz game platform is the ability to automatically record and display student data. Important aspects of the quiz attempt, categorized by question, can be recorded for each student or pair of students, depending on the group being observed, and displayed in the form of a spreadsheet that can readily be downloaded once all students have finished their attempts at the quiz. Another important feature is the availability of automated insights into the recorded data for each time a quiz game is played by a group of students, including which questions the student group excelled in and which other questions they struggled with collectively. These can help guide the teachers in providing collective formative feedback to the group of students as soon as the assessment online has been completed without the need for analyzing the data, performing calculations or generating a variety of graphs in spreadsheet software to extract relevant information and insights that could prove beneficial to the student group in question.

4.1 Analysis of Online Quiz Data

In this experiment to compare the performance of the student groups individually and in pairs on an online quiz game hosted by Quizizz on the same topic, out of the various measurements recorded in the data in the spreadsheets generated by the online software, 2 important metrics that were used were as follows:

1. Average time taken per question: as can be seen in Fig. 1, for 8 out of the 10 questions in the online formative assessments, the students attempting the online quiz game in pairs from Group 2 took more time per question, possibly due to the students in pairs taking extra time to communicate their thought processes and discuss answers with each other.
2. Average accuracy % per question: this is the percentage of students who scored correctly at a given question in the online quiz games. In Fig. 2, it can be seen that the students in Group 2 answered all questions more accurately on average compared to the students in Group 1, with the exception of Question 2. This could be due to the

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students' discussions in pairs leading to correct answers more often than the students attempting the online quizzes individually. In two of the questions, Question 6 and Question 10, Group 2 students answered correctly 100% of the time, whereas Group 1 students did not answer any question with 100% average accuracy.

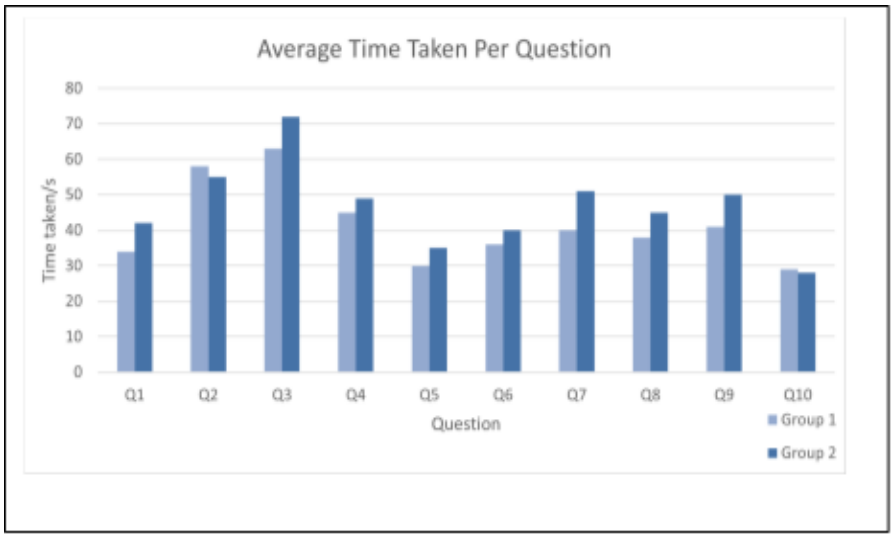

Figure 1: Average time taken per question in the online quizzes

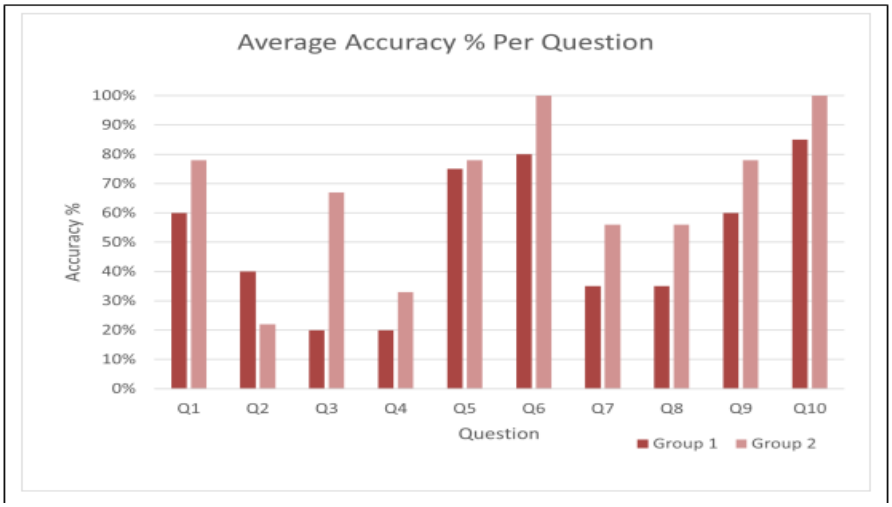

Figure 2: Average accuracy percentage by question in the online quizzes

4.2 Trends in Formative Assessment Scores

The above analysis and the resulting graphs show the average accuracy per question and average time taken for students in both groups across not just one but all three online gamified formative assessments (FAs) conducted over a period of one month. The average scores for both groups of students in these 3 online quiz games showed the trends in Fig. 3. It can be seen that both groups show similar trends in their average online formative assessments conducted using Quizizz, with Group 2 performing better in all 3

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assessments, which matches the results from the analysis and comparison of average accuracy per question between both groups of students in the 3 online quiz games conducted. Both groups show a steady decline in their scores, possibly related to the increasing difficulty level of the topics being taught and assessed at later points in time during the experimentation period, which is to be expected during the course of teaching any course or subject at any level of studies.

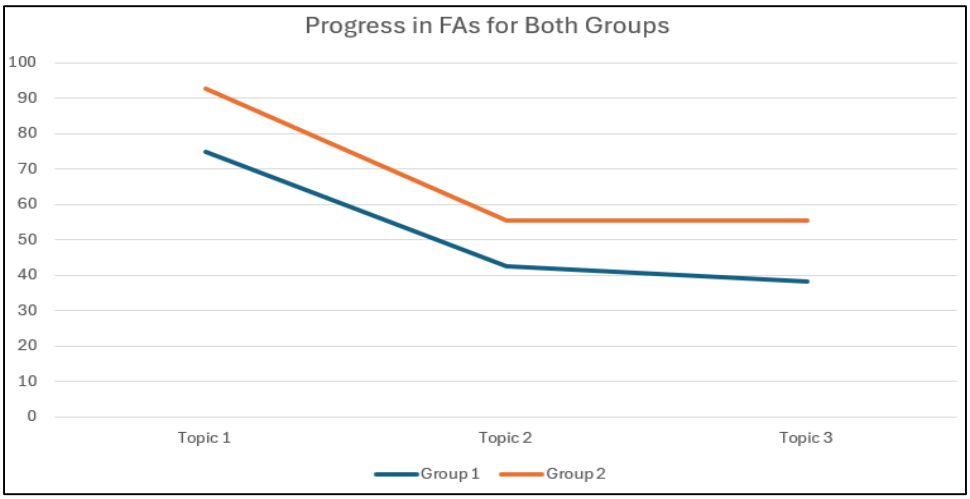

Figure 3: Trends in online formative assessment scores for both groups

4.3 Comparison of Male and Female Students' Performance

Apart from the comparisons between the 2 groups of students, one of which participated in the online gamified formative assessments individually whilst the other group participated in pairs, graphical comparisons were also carried out between the boys and girls within the same group. The bar chart in Fig. 4 shows the differences in the average scores of the boys and the girls in Group 1 for all three online quiz games conducted.

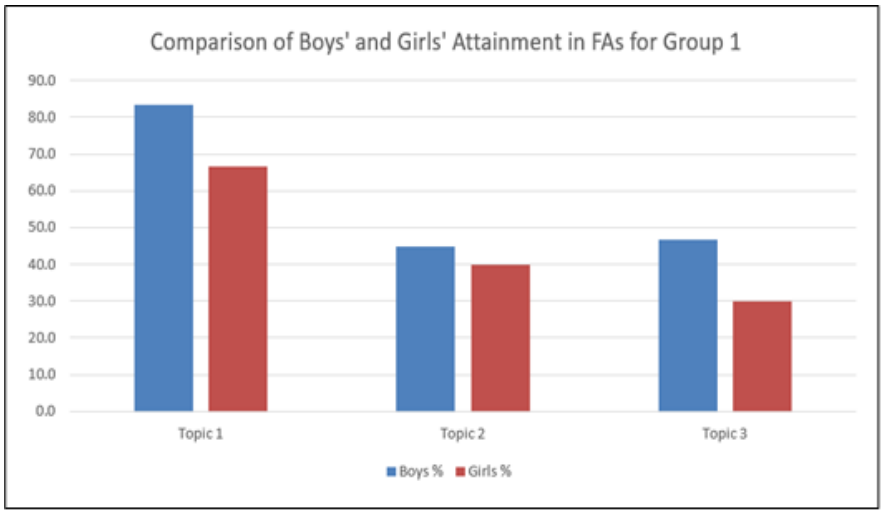

Figure 4: Comparison of boys' and girls' average scores for Group 1

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In Group 1, the male students performed better on average than the female students in all 3 topics assessed and in all 3 online gamified formative assessments conducted over the 1-month experimentation period. On the other hand, as can be seen from the next graph in Fig. 5, the situation is reversed in Group 2, with the female students outperforming the male students in the 2nd and 3rd topics with their performances in the 1st topic of Elements, Compounds, and Mixtures being close to equal.

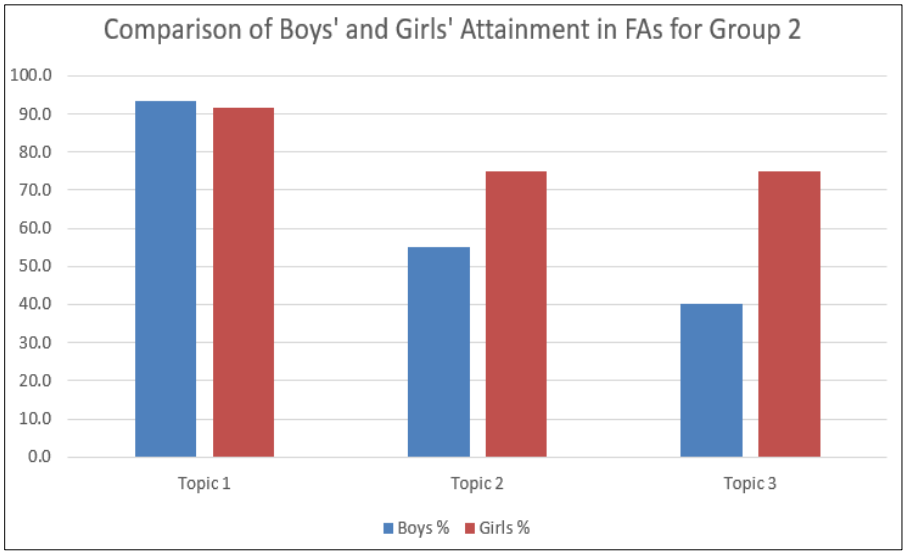

Figure 5: Comparison of boys' and girls' average scores for Group 2

These comparisons so far have only been made for the 3 topics assessed formatively online using Quizizz, the selected gamification tool. A comparison of boys' and girls' attainment levels in the summative assessment taken afterwards will be discussed in the next section.

5. DISCUSSION

5.1 Feedback Survey

After the quiz was completed by both groups of students and the correct answers shown upon completion of each student's attempt, an anonymous feedback survey was conducted using an online form. 9 questions were asked to summarize the students' experience with the online quiz conducted and any improvements or changes they would prefer to see implemented the next time an online gamified formative assessment was conducted on Quizizz or any other online quiz game platform.

A total of 25 students out of 38 who attempted the online quiz across both groups, approximately 66%, responded to the online feedback survey.

Within this survey were questions that asked whether the instructions in the online formative assessments were easy to follow and if the quizzes covered the topics assessed adequately, to which 92% of the respondents agreed. Another question asked the students to rate the difficulty level of the quizzes on a five-point scale, with a rating of

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1 meaning they were 'Too difficult' and a rating of 5 meaning they were 'Too easy'. The average rating given by the students was a 3, which meant the questions were neither easy nor difficult.

Another question in the survey asked the students to rate their overall experience on a similar five-point scale, with a rating of 1 meaning the experience was 'Poor' and a rating of 5 meaning it was 'Excellent'. The average rating for Group 1 students was 3.08, which was close to 'Neutral', whereas for Group 2, it was 3.75, which was closer to 'Good'.

The responses to this last question were used to test their relationship (if any) to their formative assessment scores using a paired two-tailed t-test, the results of which are shown in Table 3.

Table 3: Experience Ratings and Online Quiz Scores

	Group 1			Group 2		
	Mean	**St Dev**	**p**	**Mean**	**St Dev**	**p**
Boys	3.14	1.21	0.0002460	3.67	1.37	0.0000459
Girls	3.00	1.41	0.0005169	4.00	0.00	0.0013698
Overall	3.08	1.26	0.0000008	3.82	0.98	0.0000003

For both groups, and for both boys and girls within these groups, the low p-values from the t-tests conducted are all less than 0.05, which shows that there is a statistically significant link between each student's self-perceived rating of their experience with the online quiz game platform and their formative assessment scores. This result informs us of the importance of creating a well-rounded student experience with gamification which could include easy-to-follow instructions on how to answer questions and more game elements such as immediate feedback on answers given.

In the next question, the students were given a list of 5 options to choose from to recommend changes to future online gamified formative assessments, from which they could choose a minimum of 1 and a maximum of 2 options. Fig. 6 shows the students' selected recommendations from the given list of options.

For both Group 1 and Group 2, the recommendation the students gave the most was being given the ability to check their answers immediately after attempting each question, instead of being given the correct answers at the end of their quiz attempts. Implementing this recommendation in a future online quiz game could help students in answering questions later in the quiz in a better manner if they receive assistance from getting their answer attempts corrected automatically as they solve the quiz questions one by one, which could lead to more motivation for the students towards answering the next questions in the online quiz. However, the major reason why this feature was disabled for the formative assessment conducted in this experiment was to prevent any occurrence of cheating amongst the students. Getting to know the correct answer as soon as the students solve a particular question could lead to inadvertent or intentional sharing of information with other students to give them an unfair advantage. Seating plans with more space between students seated in the classroom and with screens adequately covered from other students sitting nearby could alleviate this problem.

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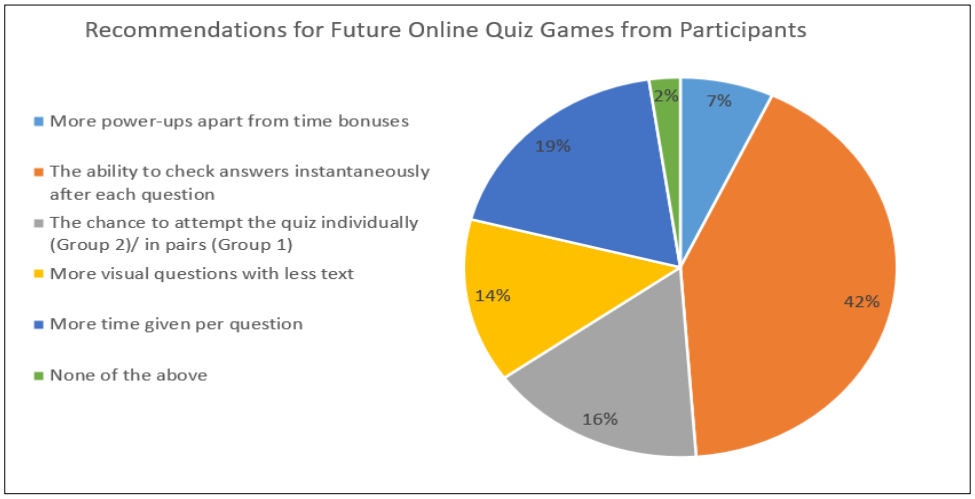

Figure 5: Comparison of boys' and girls' average scores for Group 2

5.2 Summative Assessment

To check whether conducting online quiz games as formative assessments on the same topic across two groups of students, attempting the questions either individually or in pairs, had any effect on their performance in a traditional summative assessment with questions on the same topics, a written assessment was carried out. This test was in the form of a multiple-choice examination with all topics the students had studied over the course of the academic year. This paper consisted of 40 questions to be attempted in a maximum duration of 1 hour, with 6 of these questions pertaining to the same topics that were formatively assessed using the online quiz game platform of Quizizz in the experiment conducted earlier. All students attempted this paper individually in a controlled environment, with a similar amount of time given per question or more to account for the students having to fill in a multiple-choice answer sheet with their answers in addition to the question paper given to them in which they were allowed to do their rough working.

Once the students had completed this multiple-choice examination, their papers were checked and the scores were tabulated, with 1 point for each correct answer and 0 points for each incorrect answer. The total points for each student were calculated alongside the points they received for the specific questions in the paper pertaining to the same 3 topics that had been assessed using the online quiz games for both groups of students. The average percentages of points scored were compared for both groups of students for the entire examination as well as for the subset of questions from the topics formatively assessed earlier.

Table 4 summarizes the comparison in the performance of Group 1 and Group 2 in the online formative assessments and the questions in the summative assessment on the same 3 topics, which were Elements, Compounds, and Mixtures, Reactivity Series, and Extraction of Metals.

From the data in Table 4, we can see that there is a difference of 15.8 percentage points in the performance of Group 1 and Group 2 in the online formative assessments. The

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reasons for this variation have been covered previously when the average accuracy percentages for each question in the online quiz games were compared for both groups, and the same reasons apply to the overall scores attained in the formative assessments.

Table 4: Summative assessment results comparison

	Group 1	Group 2
Online formative assessments average score	51.0%	66.8%
Summative assessment average score in the same topics	75.8%	79.6%
Summative assessment overall average score	65.4%	68.8%

The difference in the performance of the two groups in the summative assessment, both in the questions based on the same topics which were covered in the online formative assessments and in the entire summative assessment overall, is much smaller than the difference in the performance of both groups in the online formative assessments. In both aspects, Group 2, whose students participated in the online quiz game in pairs, performed marginally better, with 3.8 more percentage points gained in the questions in the summative assessment related to the topics assessed in the online formative assessments and with 3.4 more percentage points attained in the summative assessment overall.

With the summative assessment results in mind, another paired two-tailed t-test was conducted to compare formative and summative assessment scores for the 2 groups of students, the results of which are shown in Table 5.

Table 5: Quiz and Summative Assessment Scores

	Group 1			Group 2		
Topic	**Mean**	**St Dev**	**p**	**Mean**	**St Dev**	**p**
Elements, Compounds, and Mixtures	75.0	26.2	0.516	92.6	14.7	0.446
Reactivity Series	42.5	23.1	0.003	55.6	34.9	0.321
Extraction of Metals	38.3	29.2	0.001	55.6	37.3	0.033

The first topic, namely Elements, Compounds, and Mixtures, did not show a statistically significant comparison between the online gamified formative assessment and summative assessment scores since the p-values > 0.05. This topic also happens to be the topic both groups performed best in during the formative and summative assessments. For the second topic, Reactivity Series, a p-value < 0.05 is seen only for Group 1, and for the third topic, Extraction of Metals, both groups show p-values < 0.05.

These are the topics both groups scored progressively less marks in, which could mean that the link between online gamified formative assessment and summative assessment scores becomes more statistically significant as the topic becomes harder for the students to complete. For all topics, Group 1 shows lower p-values than Group 2, so there is a stronger link between online formative and summative assessment scores when students participate in the online quiz games individually versus in pairs.

5.3 Comparison of Male and Female Students' Attainment

Similar to comparisons made for the boys and girls within both groups of students between their formative assessment scores, a graphical comparison was carried out

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between their summative assessment scores for the 3 topics formatively assessed earlier. In Group 1, the boys scored better in all 3 topic areas in the summative assessment just as they had in the 3 online gamified formative assessments carried out on Quizizz. Both boys and girls improved their scores on average in the summative assessment, but the boys kept their average scores higher than the girls' scores, as shown in Fig.7

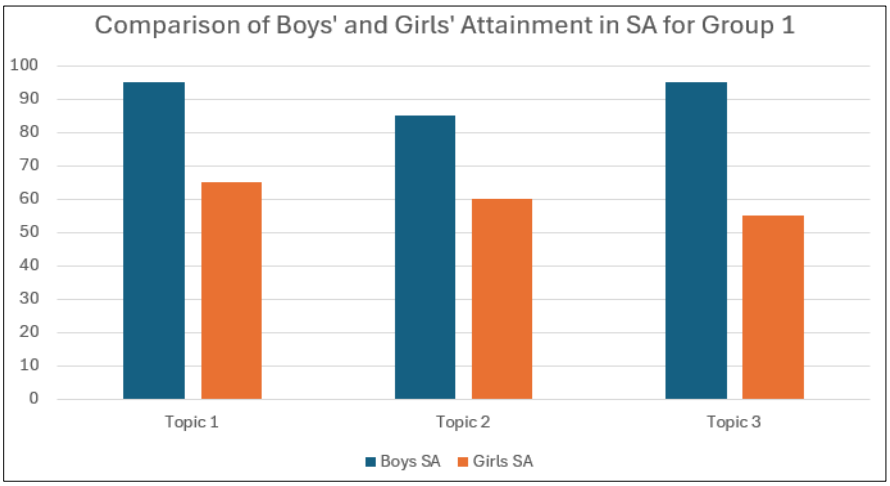

Figure 7: Boys' and girls' summative assessment scores in Group 1

In Group 2, however, some changes occurred that were captured in the bar chart for the boys' and girls' average summative assessment scores in the 3 topics assessed formatively online using a gamification tool, as shown in Fig. 8.

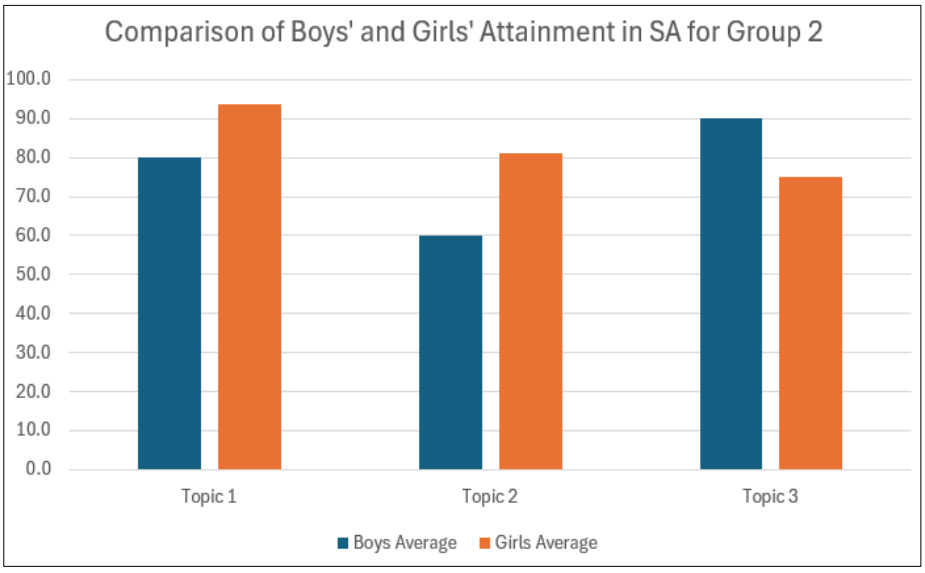

Figure 8: Boys' and girls' summative assessment scores in Group 2

In the 3 online formative assessments conducted earlier, the girls had performed better in the 3rd topic, Extraction of Metals, but the boys managed to significantly improve their performance in the summative assessment on this topic. The girls managed to perform

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much better in the 1st and 2nd topics, with the gap between the boys' and girls' attainment levels in the 1st topic increasing in the summative assessment, whereas in the formative assessments, these had been roughly equal.

5.4 Conclusion and Future Work

In this experiment, a comparison was performed between two groups of students of the same grade level and similar academic capabilities with regards to how they perform in a series of online gamified formative assessments when the students in one group participate individually and the students in the other group participate in pairs. The comparison included the time taken per question and the accuracy of the answers within the formative assessments, tests with ten multiple-choice questions on the same Chemistry topics for both groups. Further to this, a summative assessment, including questions from the topics assessed in the online quiz games, was conducted to compare and contrast the performance of the students from both groups to see if participating either individually or in pairs in an online formative assessment has an impact on summative assessment scores. An online feedback survey had also been conducted to gather the opinions of the students on this mode of online assessment.

From this research, it has been found that students participating in pairs tend to take more time on average per question, but at the same time, they get a higher average percentage accuracy in most questions. Neither group had a strong preference for either individual or team participation in the online quiz game when recommendations for improvement in future online formative assessments were collected from the students. However, one key recommendation was to allow students to check their answers right after answering each question as opposed to after the assessment is completed, which could increase motivation in students to answer the next question more accurately and gauge their relative performance compared to other students in the group using a live leaderboard.

Looking at the summative assessment, the group of students who had participated in the online quiz games in pairs had a marginally better performance in terms of average accuracy in the questions on the same topic that had been tested in the formative assessment previously.

However, this is balanced out by the similarly better performance of this group in the rest of the summative assessment overall, which means that whilst participating in an online gamified formative assessment in pairs does help attain better answer accuracy within that assessment, which can lead to a better achievement of the learning objectives, it does not have a longer-term effect in terms of drastically improved summative assessment scores.

In future work, the comparison could be extended to larger groups of students. A more robust set of criteria may be needed in the formation of larger groups of students for new experiments. This comparison could also be done for a longer period of time, for example, an entire term or semester in which multiple topics are taught. This could help establish further if there is any substantial positive correlation between student group size in online gamified lessons and summative assessment scores at the end of a term or semester.

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References

1) S. Deterding, D. Dixon, R. Khaled and L. Nacke, "From game design elements to gamefulness: defining gamification," in Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments, 2011.

2) E. Çeker and F. Özdamlı, "What “Gamification” is and what it’s not," European Journal of Contemporary Education, vol. 6, no. 2, pp. 221-228, 2017.

3) A. Marczewski, Gamification: a simple introduction, 2013.

4) S. Kim, K. Song, B. Lockee and J. Burton, "What is Gamification in Learning and Education?," Gamification in Learning and Education, pp. 25-38, 2017.

5) B. J. Arnold, "Gamification in education," Proceedings of the American Society of Business and Behavioral Sciences, vol. 21, no. 1, pp. 32-39, 2014.

6) A. Stott and C. Neustaedter, "Analysis of gamification in education," vol. 8, no. 1, p. 36, 2013.

7) J. Rabah, R. Cassidy and R. Beauchemin, "Gamification in education: Real benefits or edutainment?," in 17th European Conference on e-Learning, Athens, 2018.

8) M. Venter, "Gamification in STEM programming courses: State of the art," in IEEE Global Engineering Education Conference (EDUCON), Porto, 2020.

9) R. N. Landers, K. N. Bauer and R. C. Callan, "Gamification of task performance with leaderboards: A goal setting experiment," Computers in Human Behavior, vol. 71, pp. 508-515, 2017.

10) P. Andrade, E. Law, J. Farah and D. Gillet, "Evaluating the Effects of Introducing Three Gamification Elements in STEM Educational Software for Secondary Schools," in Proceedings of the 32nd Australian Conference on Human-Computer Interaction, New York, 2021.

11) K. Robson, K. Plangger, J. Kietzmann, I. McCarthy and L. Pitt, "Is it all a game? Understanding the principles of gamification," Business Horizons, vol. 58, no. 4, pp. 411-420, 2015.

12) P. Rodrigues, M. Souza and E. Figueiredo, "Games and gamification in software engineering education: A survey with educators," in IEEE Frontiers in Education Conference (FIE), 2018.

13) A. Marczewski, "User Types," in Even Ninja Monkeys Like to Play: Gamification, Game Thinking and Motivational Design, CreateSpace Independent Publishing Platform, 2015, pp. 65-80.

14) F. Roosta, F. Taghiyareh and M. Mosharraf, "Personalization of gamification elements in an e-learning environment based on learners’ motivation," in 8th International Symposium on Telecommunications (IST), 2016.

15) B. Monterrat, M. Desmarais, E. Lavou´e and S. George, "A player model for adaptive gamification in learning environments," LNCS (LNAI), vol. 9112, pp. 297-306, 2015.

16) M. Hassan, U. Habiba, F. Majeed and M. Shoaib, "Adaptive gamification in e-learning based on students’ learning styles," Interactive Learning Environments, pp. 1-21, 2019.

17) C. E. Lopez and C. S. Tucker, "Adaptive gamification and its impact on performance," in International conference on human-computer interaction, 2021.

18) C. E. Lopez and C. S. Tucker, "The effects of player type on performance: A gamification case study," Computers in Human Behavior, vol. 91, pp. 333-345, 2019.

19) D. A. Kaufmann, "Reflection: Benefits of gamification in online higher education," Journal of Instructional Research, vol. 7, pp. 125-132, 2018.

Jilin Daxue Xuebao (Gongxueban)/Journal of Jilin University (Engineering and Technology Edition)
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20) W. Handoko, E. Mizkat, A. Nasution and J. Eska, "Gamification in Learning using Quizizz Application as Assessment Tools," in Annual Conference on Science and Technology Research (ACOSTER), Medan, 2020.

21) M. Ekici, "A systematic review of the use of gamification in flipped learning," Education and Information Technologies, vol. 26, no. 3, pp. 3327-3346, 2021.

22) M. E. Ortiz Rojas, K. Chiluiza and M. Valcke, "Gamification and learning performance: A systematic review of the literature," in 11th European Conference on Game-Based Learning (ECGBL), 2017.

23) C. Uz Bilgin and A. Gul, "Investigating the Effectiveness of Gamification on Group Cohesion, Attitude, and Academic Achievement in Collaborative Learning Environments," TechTrends, vol. 64, p. 124–136, 2020.

24) M. Riar, "Using Gamification to Motivate Cooperation: A Review," in Forty-First International Conference on Information Systems, 2020..