Unplugged Versus Plugged Gamification - A Comparative Study in Higher Education on Engagement, Motivation and Teachers' Perception

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Overview: Gamification in education is an exciting topic that has become popular due to its positive effects on increasing motivation and engagement through game elements in teaching and learning. While digital devices or virtual environments designed for gamification are popularly used and studied, there is also a non-digital or partially digital approach called "unplugged gamification". **Goal:** This research focuses on the effects of unplugged gamification in higher education by comparing and analysing the impact of two types of gamification - unplugged and plugged gamification - based on engagement, motivation, and the influence of resource constraints on users' perception of using gamification. **Method:** The framework for this study was developed in two phases: a comprehensive literature review followed by an experimental study designed in educational settings, testing by two gamified applications, Kahoot! and Blue&Go!, referred to plugged and unplugged gamification, respectively. **Results:** The study findings indicate that some effects are similar between the two types of gamification; however, the levels of engagement in these gamification types differ in different dimensions, influenced by gender and teaching experience. Users' perception of the effectiveness and their opinion on resource constraints are measured by comparing participants' experiences with both types of gamification. The study also finds that participants' teaching experience affects the engagement experience and their perspectives.

Additional Key Words and Phrases: Unplugged Gamification, Plugged Gamification, Gamification in Education, Effectiveness of Gamification, Resource Constraints

1 INTRODUCTION

With the pervasive integration of technology in educational institutions, traditional classroom lectures are being replaced by integrated digital learning environments. Consequently, there is a pressing need to enhance student engagement during these lectures. As defined by Deterding et al. (2011) [3], gamification involves incorporating game elements and mechanics into non-game contexts. This concept finds application in various fields, including health, education, and finance. Using gamification increases user engagement and motivation in a system, as it evokes emotions and creates a stronger emotional connection between users and the design. This heightened motivation encourages users to continue utilising the system [7]. Gamification has emerged as a valuable strategy in higher education due to its proven ability to enhance various aspects of the student experience, positively impacting student engagement, motivation, confidence, attitude, perceived learning, and performance [20]. Consequently, numerous educational applications such as Kahoot or Quizziz have been developed, incorporating game elements such as points and leaderboards as alternative learning tools within the academic context [17]. However, introducing gamification into lectures requires careful preparation and game material planning beforehand. This includes tasks such as defining a game mode or designing adaptable questions to accommodate teachers' workloads, including the time required for preparation [5]. Other tools like Wooclap have improved on the drawbacks of Kahoot by providing multiple ways for teachers to create quiz questions, but they lack game features that guarantee student engagement. These digital gamification applications are called plugged gamification, which applies gamification mechanics entirely through digital means, such as websites or mobile devices[19]. In contrast, another form of gamification is the approach to the learning process by using game elements from non-digital devices, such as push buttons or other hardware devices, which is called unplugged gamification [19]. Studies have pointed out the benefits of unplugged learning, such as improved positive attitudes and emotional engagement in learning computer science [18, 21], increased learning engagement, and reduced student difficulties [2]. However, these studies did not define these activities and techniques as gamification.

In response to addressing this inconvenience, new proposals for gamified systems have emerged, which have subsequently branched out into two categories: plugged and unplugged gamified systems. The concept of plugged and unplugged gamification was explicitly described by C. Gonzalez (2023) [19] regarding their differences in applying game techniques, elements, and strategies. While gamification has been developed in various ways and with different design frameworks [15], the concept of unplugged gamification is relatively new, and limited studies and research consensus around its development are available to determine its benefits and effects [19].

This research aims to explore further the potential effects of unplugged gamification in higher education and compare these effects with its opposite form of gamification - plugged gamification, to offer additional insight into the possible benefits and effects of unplugged gamification on engagement, motivation, and performance in education, as has been suggested in the literature [23]. Additionally, this study aims to contribute to the growing body of literature on unplugged gamification and assist educators in designing more effective gamification frameworks and applications that maximise engagement, motivation, and learning outcomes while minimising resource consumption, such as time, money and workloads.

The following research questions will be conducted to find the answer to this study:

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(1) **RQ1:** What variables relate to unplugged gamification's impact on higher education?
(2) **RQ2:** How does unplugged gamification compare to plugged gamification regarding these impact indicators?
(3) **RQ3:** What is the reason for choosing gamifying techniques regarding resource constraints and effectiveness?

2 BACKGROUND

In non-game contexts like education, gamification uses game mechanics and elements, like points, badges, and levels [12], to increase engagement and motivation. On the other hand, a similar area incorporates game elements in non-game contexts but differs in purpose and implementation, called serious gaming, which is the use of games for a specific educational or training purpose as a primary tool for learning [12]. In educational settings, gamification can serve as an innovative strategy to foster active student learning by seamlessly integrating game elements into the teaching process.

With the transition to integrating technology in teaching and education, gamification has become an increasingly popular tool with various potential benefits [10]. A systematic review by Subhash et al. (2018) found that gamification improved student engagement, motivation, confidence, attitude, perceived learning, and performance in higher education. Multiple research studies have explored various options and benefits of applying gamification in classroom settings. For example, using gamified elements such as points, badges, and leaderboards can motivate students, improve knowledge, and test performance [9], while incorporating game-based learning activities can make the learning experience more interactive and engaging [14]. Others have used gamification to promote collaboration and teamwork [6]. The previous study acknowledges the effectiveness of gamification, with different gamification approaches used in digital and e-learning higher education [11]; however, limited research exploring its effectiveness of non-digital methods and needs further exploration.

Regarding gamification in education, studies have compared unplugged and plugged gamification in primary education [23]. However, there needs to be more research exploring the effectiveness of these two types of gamification in higher education. A comparative insight between the two types of gamification was conducted through a systematic review, which reviewed multiple papers, including a comparison between the two frameworks. [16], the application of both types of gamification in primary education [23], and a categorical list of game elements used in both [22]. However, more research is needed to reach a consensus on the concept and definition of "gamification and unplugged" activities and to consolidate the research community around unplugged gamification [19].

Therefore, this research proposes a methodology to investigate the effectiveness of two types of gamification in higher education: unplugged and plugged. By exploring the impact of unplugged and plugged gamification on engagement levels under five dimensions: motivation, interest, immersion, achievability and purpose, this study aims to contribute to the growing body of literature on unplugged gamification in higher education and help explore the effectiveness of engagement, motivation and learning outcomes and the influence of resource constraints in both gamification types.

3 METHODOLOGY

3.1 Literature review

A comprehensive literature review was conducted to identify appropriate variables for the experiment. The study examined the relationship between gamification and education and the impact indicators that affect this relationship. Additionally, variables that distinguish between two types of gamification, namely unplugged and plugged, were sought.

3.1.1 Database search. The literature review was searched for in several public databases, including Google Scholar, Scopus, IEEE Xplore, and ScienceDirect. A set of keywords was used to filter out the relevant documents for this study, including terms related to gamification (gamification/gamif*), words associated with the unplugging concept (unplugged/unplug*), education, and effects. Multiple search combinations based on these keywords were applied to all paper metadata to find the literature most closely related to this study.(see Table 1)

3.1.2 Filter the search results. To ensure the reliability and validity of the papers, peer-reviewed papers (published in journals, articles, magazines, conference papers, or books) were selected. The screening process included only subject areas related to social science, computer science, and psychology in specific databases to ensure the relevance of the papers' topics. Since the filtering process varied across databases, the following guidelines were laid out for the screening process:

- In Google Scholar, only select the reviewed articles
- In other databases, filter paper with valid source type, i.e. journal, article, conference proceeding, book/book series
- Only select papers which refer to the following subject area: social science, computer science, psychology
- Any undefined authors and undefined sources are excluded

3.2 Research Plan

This experimental study was conducted by the University of Twente in the Netherlands. Two different gamified activities using Blue&Go! and Kahoot! will be designed, set up, and tested to evaluate two types of gamification: unplugged and plugged. The study measured the impact of these gamification types on higher education across three dimensions: engagement, motivation, learning outcomes, and resource effectiveness. The data has been collected through a constructed survey and a list of follow-up questions. Participants included students, teachers, and university staff; various participant profiles were considered based on their demographics, roles, and expertise.

3.2.1 Applications. This study uses two gamification platforms: Kahoot! and Blue&Go!. These platforms represent plugged and unplugged gamification, respectively. Kahoot! is a popular platform that allows teachers and students to create, share, and play games for learning. Participants can use their digital devices to join the session. Blue&Go! is an unplugged platform developed by students from the University of Twente that aims to increase student engagement and reduce teacher preparation time. It is similar to Kahoot! in the use of game elements, but it uses tangible devices. During a game session,

the teacher uses the website and lecture slides to ask questions while the participants play as a team and press physical buttons to get a chance to answer. The difference between these applications is the interaction with the system. In Kahoot!, the interaction is plugged, through digital devices, while in Blue&Go!, it is unplugged through a physical and tangible device.

3.2.2 Participants. The study involved 21 participants from the University of Twente in the Netherlands, with diverse demographics in terms of gender, age, nationality, and education level. Volunteers were recruited through posters, flyers, or direct requests to participate in a gamification experiment. Eight participants had teaching experience (including Lecturers, Professors, etc.), and 13 participants had no-experienced (BSc, MSc, and PhD candidates).

3.2.3 Research Framework . The experiment had four 30-minute sessions, each replicating a short lecture on "Introduction to Gamification", where a set of questions related to gamification will be asked and answered (Appendix D). Participants, including students, teachers, and staff, joined each session and used Kahoot! and Blue&Go! in each half. For Kahoot!, the teacher had to set up the game room and create a list of questions and answers before the session, which was taken into account. For Blue&Go!, the teachers had to prepare questions in the lecture slides, and the set-up time before the session was calculated. The teacher's preparation time for the corresponding gamification application was measured, and a topic for this session was provided for teachers and staff, but they were not informed beforehand.

During the session, the impact of gamification on student engagement, motivation, and learning outcomes was measured. Participants completed survey scales after using each gamified application, and their interactions with each other and the devices were observed. The correctness of their answers, motivation, and emotional state when participating in the session were also noted. Additionally, participants were asked about their experience with the applications, including their comfort level and overall thoughts. Follow-up questions were used to measure opinions on the level of engagement and the effect of resource constraints on both types of gamification - unplugged and plugged (Appendix C).

3.3 Experimental Procedure

The experiment was conducted over four weeks, consisting of three phases: framework design, data collection, and data processing. Throughout the procedure, a survey was constructed to measure engagement, motivation, and learning outcomes, together with some demographic information, including genders, ages, and cultures; the level of familiarity with gamification was also collected. In the scope of this study, the engagement and their motivation to engage in the experiment activities were focused on and measured in the experiment session; also, the perceptions relating to the cost-effectiveness of each gamification type were measured at the end.

Initially, the experiment was planned to measure students' learning motivations and outcomes using both types of gamification during actual lecture sessions - one at the beginning of the semester and another a few weeks later. This was intended to measure student learning progress and achievement resulting from participation in either gamification type. However, the experiment required extended recruitment periods for teachers and students at the University of Twente to collaborate to set up the lectures and experiment sessions. This took more time and resources, including university funding. Given that Blue&Go! is still a product in development, and considering this study's scope and expected output, the experiment was used as a pilot study with fewer participants within classroom settings.

3.3.1 Setup and Design. During the initial phase, a classroom setting was established for teachers, staff, and students to participate in the same session. Participants were divided into three groups and interacted with two gamified applications in each session (Kahoot! and Blue&Go!). They completed a survey after each session and answered follow-up questions at the end of the experiment. Three experimental sessions were conducted, each lasting 30 minutes, with the concept of gamification and two types of gamification described. Before joining, participants received an email with the time and location of the experiment, and a short survey was distributed to measure their prior knowledge and experience with gamification, along with some demographic information. This information was used to estimate the match between participants' prior experience with gamification and their corresponding engagement during the experiment. The experimental sessions were conducted with the following agenda:

- First, participants were given a brief introduction to the concept of "gamification" and how it is used in education, along with an explanation of unplugged and plugged gamification (approx. 5 minutes).
- The first experiment involved playing Kahoot! for 5 minutes, answering five multiple-choice questions. Participants then completed the first part of the survey, including an engagement questionnaire (approximately 5 minutes).
- The second experiment involved playing Blue&Go! for approximately 10 minutes, answering five questions. Participants then completed the second part of the survey, which included an engagement questionnaire and a list of follow-up questions designed to measure their perceptions and opinions about engagement, motivation, and resource effectiveness regarding both gamification types.

3.3.2 Data Collection. In the second phase, the data was collected from different participants, including students, teachers, and university staff, either experts or non-experienced in teaching and gamification. The data was collected by completing the survey, followed by a list of exploratory questions. The data related to the following variables: engagement, motivation, learning outcomes and resource-effectiveness. For this experiment, a survey was created using accurate scales to measure student engagement and motivation to engage in activities during both plugged and unplugged gamification sessions. The scales used were identical for both types of gamification and included the "student engagement" scale. This scale was based on engagement questionnaires from Whitton (2007) [26] and consisted of a validated 5-point Likert scale with 18 items divided into seven sub-dimensions, ranging from "Strongly disagree" to "Strongly agree" (see **B.1**). Within the scope of this study, five

dimensions were used to measure engagement: *immersion, purpose, interest, achievability, and motivation.* Another short survey was distributed before the experiment to request all participants to provide their demographic information, including age, gender, culture, level of education, and expertise/experience. This was done by responding to the following questions. B.2. Also, an additional list of questions was prepared to gather insight from participants about the comparison of the efficacy between two types of gamification, unplugged and plugged, in the effectiveness on engagement, motivation, learning outcomes and influence of resource constraints in the use of gamification. The questions in **Appendix C** were tailored accordingly.

3.3.3 Data Analysis. This study conducted a quantitative analysis using two validated scales to measure participant engagement and motivation in both unplugged and plugged gamification experimental sessions. The data collected from follow-up questions were used to compare participants' opinions on the effectiveness of engagement, motivation, learning outcomes, and resource effectiveness for both types of gamification. The analysis was performed using SPSS to explore descriptive statistics, identify differences between the two types of gamification, and align with multiple variables and engagement dimensions. The study included reliability analysis for the internal consistency of each scale, descriptive analysis, and numerous statistical analyses. The first reliability analysis justified and eliminated irrelevant items based on Cronbach's alpha. Five new variables were created, referring to five dimensions generated from 13 items in each validated scale. The statistical analysis compared the effect of engagement and motivation between unplugged and plugged gamification, influenced by the difference in gender and teaching experience. Lastly, The analysis of variables constructed from follow-up questions provided the answer for participants' perception of the effect of using either type of gamification, as well as their opinion on the influence of time, money, and workload on the resource-effectiveness of each gamification.

4 RESULTS

4.1 Analysis of Literature Review

The literature review process demonstrated the number of documents categorised by the indexing combination of search terms and subsequently filtered according to the specified rules (see Table 1)

This table shows that gamification is a popular topic in education, but few studies explore its impact. Similarly, there is limited research on unplugged techniques in education. There are only a few papers available on unplugged gamification, and they are relatively new; only 7 (in Scopus), 24 (in ScienceDirect), and 1 (in IEEE Xplore) valid papers provide relevant information for unplugged gamification in education, and only 13 (in ScienceDirect) and 1 (in Scopus) document measuring its impact.

Out of the available papers, only a small number provide relevant information. To gain more insight, a review of the papers was planned to identify how the authors arrived at their conclusions. After filtering through four databases and identifying standard connections between relevant papers, six papers were eligible for full-text review. The table below outlines each paper's main findings and purposes related to the research topic: variables affecting the impact of unplugged gamification in education (Table 2).

Table 1. Number of documents based on the indexing search terms.

	Gamif* AND Education	Gamif* AND Education AND Effect	Unplug* AND Education AND Effect	Gamif* AND Unplug* AND Education	Gamif* AND Unplug* AND Education AND Effect
Google Scholar	10,300	8,610	1,230	123	106
Scopus	4,754	838	40	7	1
IEEE Xplore	1,011	116	4	1	0
Science Direct	2,809	1,987	606	24	13

Table 2. Summary of papers relating unplugged gamification and education.

Authors	Variables	Resource status
Madariaga et al., 2023 [13]	motivation, engagement, enjoyment of in-game mechanics and game elements	Full-text
Zhan et al., 2022 [27]	student motivation, and cognitive load; thinking skills	Full-text
Cheng et al., 2023 [1]	motivation learning confidence (confidence to complete the experimental activities)	Full-text
Tsarava et al., 2019 [24]	positive experience, computational thinking	Full-text
Esteve-Mon et al., 2019 [4]	computational thinking, learning gain, technical difficulty	Full-text
Huang & Looi, 2021 [8]	computational thinking, flexibility, student participation	Full-text

The table 2 displayed various research approaches related to "unplugged" and their primary findings and outcomes in each paper. The variables explored in each study were identified after summarising ten papers. These studies have employed different methodologies, such as literature reviews, meta-analyses, or comparative experiments between multiple forms of game-based activities (such as gamified robotics, card games, and board games) to examine the effects of unplugged and plugged gamification on variables such as engagement, motivation, learning performance, computational thinking, cognitive load, and cost-effectiveness. The resource status of these papers is also included in the table. Most of these papers are in full text, allowing for a more in-depth exploration of the

methodologies, results, and limitations. In contrast, others are only available as abstracts, limiting the depth of this analysis.

However, there are some limitations to this analysis, mainly concerning the content and subject area of the papers that were examined:

(1) Most of these studies focus on students' computational thinking within the subject area of computer science, which is not a representative example of education.
(2) The definitions of *"unplugged gamification"* are not explicitly used, so some studies merely compare "unplugged" and "plugged" activities, such as online games and offline games related to education.
(3) Limited accessibility to all related papers restricts this analysis's comprehensiveness, meaning the analysis's outcome cannot be generalised to the effect of unplugged gamification in education.

Overall, this content analysis identified various factors that influence the impact of unplugged gamification in education, including engagement, motivation, learning performance, and cost-effectiveness. However, these factors were measured by different experiments and studies on students' computational thinking, which can limit the generalisation of these variables. Hence, in the second phase of this study, the actual effectiveness of these variables on unplugged and plugged gamification in education was tested through an experiment.

4.2 Comparing Engagement and Motivation between plugged and unplugged gamification

4.2.1 Cronbach's Alpha. Cronbach's alpha was used to calculate the internal consistency of the scale used to measure Kahoot! and Blue&Go!. However, given the differences between these applications regarding gameplay and interaction activities, some items may not apply to the specific scale. Reliability analysis was conducted beforehand in SPSS to identify the item to be excluded. The reliability test showed that the validated scale was suitable for Kahoot! experiment, with a Cronbach's alpha value of 0.733. However, the reliability of this scale for the Blue&Go! experiment was somewhat questionable at 0.661, indicating that some items used for the scale may not be suitable for this specific experiment. Consequently, a deeper analysis was conducted to identify which items should be eliminated from the scale. Using the Cronbach's alpha analysis in SPSS with the "Scale if Item Deleted" option selected, items 5 - "It was clear what I could learn from the activity" and 8 - "I was not interested in exploring the options available" were suggested for removal due to poor item-total correlation values of -0.265 and -0.101, respectively. Removing these items generated an acceptable Cronbach's alpha of 0.76 for the Blue&Go! scale. The table below displays the final Cronbach's alpha, which is considered acceptable for further analysis.

Gamified Application	α	N of Items
Kahoot!	0.733	13
Blue&Go!	0.761	11

The next step was to reconstruct the scale items by grouping them into several sub-dimensions; five new variables representing five different dimensions were created for each scale by computing the mean value of selected items using SPSS, including Motivation (items 1 and 9), Achievability (items 2 and 3), Interest (items 4, 8, and 12), Immersion (items 6, 10, and 11), and Purpose (items 5, 10, and 13). The division was based on the validated scale used for this experiment study (see Appendix B.1). However, for the Blue&Go scale, items 5 and 8 were removed for Blue&Go scale to ensure internal consistency, and as a result, the Interest dimension was constructed only by items 4 and 12, and the Purpose dimension was formed by items 10 and 13. After having the data for these new variables, a descriptive analysis was conducted to gain insight into the data. This analysis included two main scales, referring to Kahoot and Blue&Go, separated by five sub-dimensions; variables related to resource constraints; and the participants' opinions on the engagement, motivation, and learning outcomes of each between the two sessions. The results were shown in the Appendix 1.

4.2.2 Descriptive Statistics. The descriptive statistics revealed that both types of gamification had high engagement levels in motivation, interest, and immersion. However, the plugged gamified activities using Kahoot! showed slightly higher engagement overall, with higher mean values for motivation, achievability, and interest than unplugged activities. The comfortability and satisfaction of participants with the platforms used could also influence the difference. As shown by the figure, the value of KComfort (Comfortable with Kahoot!) was [μ=4.24, σ=0.63], which was higher than the value [μ=3.86, σ=0.91] of BGComfort (Comfortable with Blue&Go!). The figures indicated that the immersion with Blue&Go!, a representative of unplugged gamification, is higher [μ = 3.94, σ= 0.61] than the immersion with Kahoot! [μ=3.84, σ=0.70], with a broader range of answers (between 3.0 and 5.0 on the Likert scale). However, both gamification activities showed limitations in the purpose dimension, with relatively low mean values on both scales ([μ = 2.89, σ=0.43] for Kahoot! and [μ=2.98, σ=0.54] for Blue&Go! respectively).

4.2.3 Compared mean. The descriptive analysis did not reflect the influence of other independent variables on the differences in the mean value of each dimension for each gamification type; also, the observed value did not provide clear differences across dimensions. Therefore, a mean comparison approach was conducted to gain deeper insight into these influences. This process was done using the Compared Means function in SPSS. The mean value of five different dimensions was compared between scale data of Kahoot! and Blue&Go!. Two additional independent variables were used to represent two demographic information of participants: gender and level of education.

In the first comparison, "gender" was used as an independent variable. The following table (Appendix 2) summarised the results obtained from the analysis. According to the table, the majority of participants were male (16 records), and five were female. However, it was indicated that females had a higher level of motivation [μ=4.00 > μ=3.88], interest [μ=4.20 > μ=4.10], and immersion [μ=4.07 > μ=3.78] in Kahoot! compared to males. On the other hand, males had a better engagement in achievability [μ=4.13 > μ=3.80] and purpose [μ=2.96 > μ=2.68] of the gamified activities than the experience

in females. The same pattern was also observed in the dimensions of Blue&Go! engagement experience. Besides, the table also showed an interesting insight that the engaging experience, including motivation, interest, and immersion, of males with unplugged gamification - Blue&Go!, was relatively higher than the corresponding dimensions in experiencing with plugged gamification - Kahoot! The observed pattern was the opposite for the experience of females with the two types of gamification in these dimensions.

The second mean comparison explores the mean values of different dimensions in two types of gamification while considering the influence of "teaching experience" as an independent variable. From the demographic data, only the education level or current position of participants was retrieved from the survey, so the first step was to convert five categories of a current position into two types of teaching experience: no-experienced (including BSc, MSc, and PhD Candidates) and experienced (including Lecturers and Professors), with the number of 13 and 8 participants respectively. The following figure (see Appendix 3) illustrates the difference in mean values for each type of gamification referring to each dimension and level of teaching experience. According to the figure, there was a significant difference in the level of engagement in all dimensions between no-experienced and experienced participants. In the Kahoot! experiment, the results displayed that participants with no teaching experience (BSc, MSc student, or PhD candidate) had higher levels of engagement in motivation [μ=4.19 > μ=3.44], achievability[μ=4.35 > μ=3.57], interest [μ=4.54 > μ=3.46], immersion [μ=3.97 > μ=3.63]. In contrast, only the purpose dimension had a slightly lower mean value [μ=2.87 < μ=2.92]. In Blue&Go! scale data, a similar pattern was demonstrated by the figure, where the motivation [μ=4.23 > μ=3.44], achievability [μ=3.96 > μ=3.06], interest[μ=4.35 > μ=3.63], and immersion [μ=4.00 > μ=3.67] had higher mean values, and purpose had a lower mean value [μ=2.96 < μ=3.00]. This observation explains that participants with more teaching experience were more familiar with the gamification platforms, so they showed less engagement, including interest and immersion in gamified activities. However, experienced participants understood more about the tasks and the purpose of the gamified activities. Additionally, an interesting finding when comparing the mean value of each dimension between two gamification types to either of the participant categories showed that the unplugged gamification engagement (Blue&Go!) had higher levels of motivation, immersion, and purpose for both non-experienced and experienced participants, while the achievability and interest were considerably lower in the mean value.

4.3 Analysis of Participants' Perceptions

4.3.1 Perceptions on the effect of gamification. The descriptive statistical report in the Appendix 1 provides an overview of the mean values for the following variables: *EngagementCompare, MotivationCompare, and LOCompare*. These variables were used to measure participants' perceptions and opinions when comparing the effects of unplugged gamification with plugged gamification. By answering these variables, the comparison aimed to observe the difference in the effectiveness of each gamification type (unplugged or plugged) on student engagement, motivation, and learning outcomes (in the long run), as measured by participants' experiences with both gamification types. The figure results showed that the influence of unplugged gamification (with Blue&Go!) on these effects, including engagement [μ=3.52, σ=0.93], motivation[μ=3.57, σ=1.08], and learning outcomes [μ=3.38, σ=0.74] on students, was higher compared to plugged gamification (with Kahoot!). However, the differences were insignificant, and the variation was high, as indicated by the high standard deviation value, making these differences considerably negligible. Furthermore, a mean comparison approach was conducted to determine the influence of teaching experience on participants' opinions of these effects, considering that some participants had different teaching experiences: non-experienced and experienced, as mentioned in the previous section. The reported result of this analysis was shown in Appendix 4. It was found that participants who did not have teaching experience thought that unplugged gamification had a more significant influence on student engagement [μ=3.69 > μ=3.25], motivation [μ=3.77 > μ=3.25], and learning outcomes [μ=3.46 > μ=3.25] compared to plugged gamification, but these differences were relatively small.

4.3.2 Perceptions on resource constraints to gamification choice. The survey used in this study included follow-up questions designed to measure participants' opinions on the influence of resource constraints (RC) when deciding between two types of gamification: unplugged (Blue&Go!) and plugged (Kahoot!). The survey data showed that most participants agreed that time and workload influenced their decisions on using gamification in education. The descriptive data demonstrated how participants considered these resource constraints when comparing the two types of gamification, as reported by the variables *RCTime, RCMoney, and RCWorkloads* (Appendix 1). The survey asked participants that "Do you think the unplugged gamification (Blue&GO!) requires less time/money/workloads for preparation than plugged gamification (Kahoot!)?" and the data indicated that unplugged gamification required more resources compared to plugged gamification, with mean values of μ=2.67 for time, μ=2.43 for money and μ=2.81 for workloads. However, since the influence of resource constraints also depended on the level of teaching experience, a deeper analysis was performed using SPSS, as reported in the following table (see Appendix 5). The study showed that people with no teaching experience considered unplugged gamification to consume more time [μ=2.69 > μ=2.63] and workloads [μ=2.85 > μ=2.75]. In contrast, plugged gamification was perceived to cost more money [μ=2.23 < μ=2.75] compared to the opinions of people with teaching experience.

5 DISCUSSION

This study examines the effects and values of unplugged and plugged gamification in higher education. It independently tests and measures both types to identify similarities and differences in engagement, motivation, and resource constraints. The methodology includes a literature review and an experiment on students, teachers, and university staff to test the effect of gamification in practical classroom settings. A short follow-up question list gathers participants' opinions on usefulness and effectiveness. The expected output of this study is to determine the potential of using unplugged gamification in education compared to the plugged one.

The first research question was answered by a literature review of databases conducted to find the impact of unplugged gamification in higher education. Keyword filters related to gamification, education, and gamification effects were used to narrow down relevant papers. It was found that unplugged gamification can enhance students' computational thinking skills, determined by four key effects: engagement, motivation, learning outcomes, and resource effectiveness. However, the limited number of research papers on this topic restricts the generalisation of these variables' influence on higher education.

To answer the second research question, the current study explored the effectiveness of two types of gamification (unplugged and plugged) on student engagement and motivation through an experiment. The findings showed that both types had a positive impact, with participants being more engaged when using the plugged system. Quantitative analysis showed that participants were more engaged when interacting with the plugged gamification platform (Kahoot!) than the unplugged one (Blue&Go!), influenced by their comfortability and familiarity with the system. However, both types had limitations in providing a clear purpose for participants. Considering gender, females were more motivated, interested and immersed in gamification, while males performed better in understanding the purpose of the activities. It showed that males enjoyed unplugged gamification and females enjoyed plugged ones. Regarding the teaching experience of participants, it was negatively correlated with motivation and interest in gamification but positively correlated with understanding the purpose. Comparing the two types of gamification, unplugged gamification showed higher levels of motivation, immersion, and purpose, while the achievability and interest were lower compared to the plugged one.

The third research question examined the impact of resource constraints and two types of gamification on engagement, motivation, and learning outcomes. Participants' opinions were gathered through follow-up questions. The analysis showed that unplugged gamification was perceived to have a more significant effect on engagement, motivation and learning outcomes than plugged gamification. Resource constraints were also considered more important in unplugged gamification, especially regarding time and workload. However, those with teaching experience had different perspectives. Students thought unplugged gamification to be more effective and influenced more by time and workload, while teachers and professors saw monetary cost as more important in unplugged gamification.

6 CONCLUSIONS

This experimental study's results align with previous findings on using unplugged gamification, or at least unplugged educational activities. This study provides evidence that gamification, specifically unplugged gamification, positively affects engagement and motivation. Additionally, this study brings an overview of some recognisable effects of unplugged gamification and introduces an example of an unplugged gamified application used in an educational context; it also explores a side effect of resource constraints and users' perceptions of two types of gamification: unplugged and plugged. The main findings of this study were through a comprehensive small-scale experiment and mean comparison methodologies on unplugged and plugged gamification.

According to Gonzalez (2022), unplugged gamification is a new concept with limited research on its use in education. Previous studies showed that gamification could positively affect engagement, motivation, learning outcomes, and performance [9, 20]. The literature review of this study found that these effects were also significant for students involved in unplugged activities related to computational thinking [13, 25, 27]. Results showed that engagement and motivation to engage with the gamification activities were positive, with the level of engagement being higher in plugged gamification (with Kahoot!) compared to the other (with Blue&Go!), which is consistent with the previous findings of Tsarava et al. (2017), tested in primary education. However, the perception of the purpose of both gamified activities is quite limited, and these engaging experiences are also influenced by the familiarity and comfortability of participants with the gamified system they used. The unplugged gamified system provided more motivation, interest, and immersion in the activities but was lower achievability and interest than the plugged one. The study revealed that the participant's background also influenced their experience and perception toward either type of gamification. The conclusion matches the findings of this study in the influence of teaching experience on the level of engagement, where participants with no teaching experience showed a stronger level of motivation, interest, and immersion with both gamification types and experiences, i.e., unplugged and plugged. Toda et al.(2022) also noted that teachers' bias in accepting gamification is influenced by a lack of theoretical and practical knowledge and a shortage of time and resources. The experimental study aligned with the previous findings, indicating that resource constraints, such as time, money, and workload, can indeed affect a participant's intention to use gamified applications, and it is stronger for experienced participants.

This study found positive results from the comparison and noteworthy findings for unplugged gamification, but some limitations remained. The experiment was small-scale and had limited participants and testing sessions, so the values used for comparison were not standardised. To better generalise the findings, larger-scale and long-term research should be conducted with more balanced participants regarding gender, education level, and prior experience with gamification. The level of learning outcomes is yet to be determined, and also follow-up interviews with teachers could provide more insights into their experiences with each gamified application. Despite these limitations, the study produced positive findings that suggest the potential of unplugged gamification in different fields and for other learning purposes. Moreover, the study indicated that the design of gamification frameworks could be more efficient in terms of time, money, and workload, which could consequently influence the decision to use gamification in education.

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A ANALYSIS FIGURES

A.1 Analysis of Engagement and Motivation between two gamification types

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
KComfort	21	3	5	4.24	.625
BGComfort	21	2	5	3.86	.910
EngagementCompare	21	1	5	3.52	.928
MotivationCompare	21	1	5	3.57	1.076
LOCompare	21	2	5	3.38	.740
RCTime	21	1	5	2.67	.966
RCMoney	21	1	5	2.43	1.076
RCWorkloads	21	1	4	2.81	.814
Motivation_K	21	1.50	5.00	3.9048	.86051
Achievability_K	21	2.50	5.00	4.0476	.77306
Interest_K	21	2.00	5.00	4.1270	.90968
Immersion_K	21	2.33	5.00	3.8413	.69617
Purpose_K	21	2.00	3.67	2.8889	.42601
Motivation_BG	21	2.50	5.00	3.9286	.77919
Achievability_BG	21	2.00	5.00	3.6190	.86465
Interest_BG	21	2.50	5.00	4.0714	.84092
Immersion_BG	21	3.00	5.00	3.9365	.61118
Purpose_BG	21	2.00	3.50	2.9762	.53563
Valid N (listwise)	21				

Fig. 1. Descriptive Statistics

Report

Gender_Text		Motivation_K	Achievability_K	Interest_K	Immersion_K	Purpose_K	Motivation_BG	Achievability_BG	Interest_BG	Immersion_BG	Purpose_BG
Female	Mean	4.0000	3.8000	4.2000	4.0667	2.6667	3.9000	3.3000	4.3000	4.2667	2.7000
	N	5	5	5	5	5	5	5	5	5	5
	Std. Deviation	.79057	.83666	.93095	.64118	.52705	.96177	1.09545	.83666	.54772	.57009
Male	Mean	3.8750	4.1250	4.1042	3.7708	2.9583	3.9375	3.7188	4.0000	3.8333	3.0625
	N	16	16	16	16	16	16	16	16	16	16
	Std. Deviation	.90370	.76376	.93269	.71718	.38249	.75000	.79517	.85635	.60858	.51235
Total	Mean	3.9048	4.0476	4.1270	3.8413	2.8889	3.9286	3.6190	4.0714	3.9365	2.9762
	N	21	21	21	21	21	21	21	21	21	21
	Std. Deviation	.86051	.77306	.90968	.69617	.42601	.77919	.86465	.84092	.61118	.53563

Fig. 2. Compared mean value of different Engagement dimensions influenced by Gender

Report

TeachingExperience		Motivation_K	Achievability_K	Interest_K	Immersion_K	Purpose_K	Motivation_BG	Achievability_BG	Interest_BG	Immersion_BG	Purpose_BG
Experienced	Mean	3.4375	3.5625	3.4583	3.6250	2.9167	3.4375	3.0625	3.6250	3.6667	3.0000
	N	8	8	8	8	8	8	8	8	8	8
	Std. Deviation	.90386	.77632	.88976	.70006	.49602	.62321	.49552	.87627	.56344	.37796
No-experienced	Mean	4.1923	4.3462	4.5385	3.9744	2.8718	4.2308	3.9615	4.3462	4.1026	2.9615
	N	13	13	13	13	13	13	13	13	13	13
	Std. Deviation	.72280	.62532	.66023	.68667	.39764	.72501	.87706	.71835	.59914	.62788
Total	Mean	3.9048	4.0476	4.1270	3.8413	2.8889	3.9286	3.6190	4.0714	3.9365	2.9762
	N	21	21	21	21	21	21	21	21	21	21
	Std. Deviation	.86051	.77306	.90968	.69617	.42601	.77919	.86465	.84092	.61118	.53563

Fig. 3. Compared mean value of different Engagement dimensions influenced by Teaching Experience

A.2 Analysis of Participants' Perception

Report

TeachingExperience		EngagementCompare	MotivationCompare	LOCompare
Experienced	Mean	3.25	3.25	3.25
	N	8	8	8
	Std. Deviation	1.035	1.035	.463
No-experienced	Mean	3.69	3.77	3.46
	N	13	13	13
	Std. Deviation	.855	1.092	.877
Total	Mean	3.52	3.57	3.38
	N	21	21	21
	Std. Deviation	.928	1.076	.740

Fig. 4. Compared Effect of Gamification on Student Engagement, Motivation, Learning Outcomes, influenced by Teaching Experience

Report

TeachingExperience		RCTime	RCMoney	RCWorkloads
Experienced	Mean	2.63	2.75	2.75
	N	8	8	8
	Std. Deviation	.744	.886	.886
No-experienced	Mean	2.69	2.23	2.85
	N	13	13	13
	Std. Deviation	1.109	1.166	.801
Total	Mean	2.67	2.43	2.81
	N	21	21	21
	Std. Deviation	.966	1.076	.814

Fig. 5. Compared Effect of Resource Constraints on Gamification choice, influenced by Teaching Experience

B SURVEY INSTRUMENT

B.1 Engagement Questionnaires

- (R) - reversed question
- (motivation/achieve/interest/immersion/purpose) - dimension of engagement

"Thinking about the session you have just done, please indicate the level to which you agree with the following statements."

(1) I wanted to complete the activity (motivation)
(2) I found the activity frustrating (achieve) - (R)
(3) I felt that I could achieve the goal of the activity (achieve)
(4) I found the activity boring (interest) - (R)
(5) It was clear what I could learn from the activity (purpose) - (R)
(6) I felt absorbed in the activity (immersion)
(7) The activity was pointless (purpose) - (R)
(8) I was not interested in exploring the options available (interest) - (R)
(9) I did not care how the activity ended (motivation) - (R)
(10) I felt that time passed quickly (immersion)
(11) I found the activity satisfying (immersion)
(12) I did not enjoy the activity (interest) - (R)
(13) The feedback I was given was useful (purpose) - (R)

B.2 Demographic Questions

- What is your current age? *Please provide a numerical answer between 0 and 99.*
- What is your gender? *Please select one of the following options: Male, Female, Non-binary, or Other.*
- What is your nationality?
- What is your highest level of education or current position? *Please select one of the following options: BSc, MSc, PhD, Lecturer, or Other (please specify).*
- How familiar are you with using gamification? *Please select the option that best describes your level of familiarity using a Likert scale.*

C FOLLOW-UP QUESTIONS

- What are your general thoughts on effective of gamification as an educational tool? *(Ineffective - Effective)*
- How familiar are you with gamification before participating in this session? *(Not Familiar - Extremely Familiar)*
- How likely do you think this session is to incorporate gamification? *(Unlikely - Likely)*
- Do you think unplugged gamification (Blue&Go!) better influences students than plugged gamification (Kahoot!) in student engagement/motivation in engaging / learning outcomes? *(Definitely not - Definitely yes)*
- Based on the following resource constraints (time, money, workloads), which affect the intention to use gamification in education? *(Select multiple answer: Time, Money, Amount of workloads)*
- Do you think the unplugged gamification (Blue&Go!) requires less time for preparation/money cost/workloads (questions, tasks, rewards) than plugged gamification (Kahoot!)? *(Definitely not - Definitely yes)*

D QUESTIONS USED IN EXPERIMENT SESSION

(1) **Which definition best explains gamification?**
   (a) The process of creating games for entertainment.
   (b) The gameplay enhances user cognitive abilities.
   (c) The use of game elements in non-game contexts to engage and motivate people to achieve their goals.
   (d) The study of video games and their impact on society.
   Answer: C

(2) **Which of the following is an example of gamification in education?**
   (a) Earning rewards from a tricky question in a book
   (b) Earning points and badges in video games
   (c) Earning points and badges on an educational app
   (d) A board game designed to increase student's engagement and motivation
   Answer: C

(3) **What are the psychological principles behind gamification?**
   (a) Reduce stress, fear, and pressure.
   (b) Mood adjustment automatically.
   (c) The gameplay enhances user cognitive abilities.
   (d) Motivation, engagement, and behaviour changes.
   Answer: D

(4) **Which is an example of unplugged gamification in education?**
   (a) A virtual-reality headset designed for students to increase engagement
   (b) A push button to engage, compete and win the rewards
   (c) A educational system with a button to press and answer educational questions
   (d) An interactive learning website where you can earn rewards for completing tasks
   Answer: C

(5) **Why is gamification important?**
   (a) It makes tasks more boring and tedious.
   (b) It is an effective way to engage and motivate people to perform tasks.
   (c) It is a popular concept that defines an effective education.
   (d) It is a strong tool that helps teachers and students complete tasks more easily.
   Answer: B

(6) **Which of these are types of gamification?**
   (a) Non-plugged and Plugged-in.
   (b) First-person and third-person.
   (c) Unplugged and Plugged.
   (d) Single-player and multiplayer.
   Answer: C

(7) **What is the difference between unplugged and plugged gamification?**
   (a) Unplugged using non-virtual games / Plugged using virtual games
   (b) Unplugged is interaction with a non-virtual environment/ Plugged is with a virtual environment
   (c) Unplugged is a system without plugged-in cable and wires / Plugged needs cables and wires
   (d) Unplugged using games for education / Plugged using games for healthcare
   Answer: B

(8) **What are the benefits of using gamification in education?**
   (a) It is an effective way to help teachers and students engage and motivate themselves to save time studying
   (b) It is an effective way to encourage students to engage in the games and motivating to play
   (c) It is an effective way to reduce stress and peer pressure by letting students continuously engaging
   (d) It is an effective way to increase student engagement and motivation to learn
   Answer: D

(9) **How can we measure the effectiveness of gamification in education?**
   (a) By the number of badges and points earned by the users.
   (b) By the amount of time users spend on the gamified activity.
   (c) By the ranking position of the user.
   (d) By the achievement of the intended learning outcomes.
   Answer: D

(10) **What are the future of gamification and its potential positive impact on society?**

(a) Gamification will become positively impact the way people use games as effective tools
(b) Gamification will motivate and engage people because they are more interested in games.
(c) Gamification will influence task efficiency because everything is made digitally in a virtual environment.
(d) Gamification will motivate and engage people, significantly affecting task efficiency and outcomes.

Answer: D