The Impact of Gamified Assessment on the Learning Burnout of Undergraduate Computing Students: a Quasi-experimental Research

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Abstract: Learning burnout refers to the negative attitude and behavior of being bored with learning due to learning pressure or lack of learning interests. It affects not only students' academic performance but also their physical and mental health. Currently, the research on learning design to alleviate learning burnout has only been the subject of a few studies. Considering that gamified assessment theoretically gave it potential to affect students' learning burnout, 120 undergraduate computing students at a university in mainland China participated in this study to investigate whether such a learning process was conducive to affecting learning burnout. The research was a quasi-experimental design with pretest and posttest. For the experimental group (n=60), gamification elements were integrated into two sessions including the question and answer sessions and after-class quizzes by Quizizz for six weeks (2 hours per week). During the data collection, all participants involved completed the pretest and posttest of the Maslach Learning Burnout Inventory-Student Survey via an electronic questionnaire. The quantitative data were analyzed through ANCOVA. This study found that students' learning with gamified assessment for six weeks did contribute to alleviating students' learning burnout, particularly in terms of cynicism and low efficacy. The findings can be a reference for exploring the integration of gamified assessment into tertiary education.

Keywords: Gamified assessment, learning burnout, gamification, quasi-experimental design

1. Introduction

With the widespread use of information technology in tertiary education, mental health risks, especially those related to learning burnout among undergraduate students, are particularly obvious (Zhao et al., 2022). Affected by learning burnout, students' characteristics of poor learning performance become more common, including inattentiveness, low learning efficiency, high learning anxiety, and even resistance to learning. Some schools have put forward corresponding psychological counselling suggestions aiming at effectively alleviating the emotional problems of learning (Ates, 2016).

In addition to psychological guidance, trying new learning and teaching methods can be another way to deal with learning burnout. In order to prevent student burnout during the learning process, it is crucial to keep their enthusiasm for the subject alive. One way to mobilize their interest in learning is through gamified assessment (Huang et al., 2019). Gamification can be defined as the use of game elements in non-game environments (Deterding et al., 2011). When gamification is applied to the educational area, it motivates and educates learners through appropriate game elements. Gamification has been exhibited as an effective approach for teaching computer courses in tertiary education (Ahmad et al., 2020). The use of gamification in educational contexts has led to the creation of new assessment methods. More specifically, game elements such as badges and levels are added to student

assessments. Past research has shown that gamification has been effectively implemented in a number of learning environments (Chung & Lin, 2022; Saleem et al., 2022). However, the use of gamification to assess student learning has only been the subject of a few studies (Zhang & Fang, 2019). Notably, little research has been done to investigate the effects of gamified assessment in the context of tertiary education.

This study aims to explore whether gamified assessment contributes to alleviating undergraduate computing students' learning burnout, hoping to provide a reference for exploring the improvement of such a problem. A more thorough analysis of how gamified assessment affects multiple dimensions of learning burnout has been conducting in the second stage of the research project based on the qualitative findings which will be reported in another paper.

The research question of the present study: *Does gamified assessment affect the learning burnout of undergraduate computing students?*

2. Literature Review

2.1 Gamification in Education

Gamification is the use of game elements or game design techniques in non-game contexts, with the aim of introducing game elements without detaching them from realistic contexts (Werbach et al., 2012). Gamification has been shown to enhance learning (Andriamiarisoa, 2018; ONeill et al., 2018). It is an effective way of boosting learners to achieve learning outcomes, motivating learners, and facilitating learning (Göksün & Gürsoy, 2019). MacKinnon et al. (2015) conducted a quasi-experimental study to investigate the impact of gamification on students' motivation, and their conclusions indicated that gamification significantly improved learning outcomes. The gamification elements can be progress bars, leaderboards and badges, employed as alternative or supplementary assessment methods to scores (Tsay et al., 2018). Numerous educational research has used gamification for the last decade to stimulate learning motivation, increase engagement and accelerate learning (Dicheva et al., 2015). Therefore, further exploration and research into the integration of gamification in education is necessary to fully realize its potential in enhancing the instructional effectiveness. In this study, gamification was integrated into the assessment.

2.2 Gamified Assessment

When the term "gamified" is applied to assessment, it describes a design process that incorporates gaming aspects to improve an existing assessment method (Georgiou & Nikolaou, 2020). Gamified assessment can creatively apply gamification elements to related tasks. It gives the potential to promote the efficiency of students' information exchange to achieve the purpose of promoting learning (Shute, 2008).

Various gamification elements can be incorporated into existing assessments, including progress bars, points, and badges (Landers et al., 2015). The implementation of gamified assessment is usually carried out by the teacher using some gamified assessment systems (Delacruz, 2011), such as Kahoot!, Socrative and Quizizz. Teachers can rapidly and effectively assess students' learning with the aid of gamification systems and students can benefit from immediate feedback. A recent empirical study has further confirmed that technology-enhanced gamified assessment was more motivating than paper tests and improved academic performance (Zainuddin et al., 2020). Using gamification interaction could improve course completion, interaction and motivation rate (Hassan et al., 2021). Dias (2017) found that gamified assessment increased the proportion of students participating in the classroom. A literature review concluded that the majority of related papers have concluded that gamified assessment has positive effects on learning motivation, learning achievement, and learning satisfaction (Wang & Tahir, 2020).

In summary, gamified assessment is an innovative approach to assessment that incorporates game elements into educational contexts to positively motivate and engage

students in learning. Gamified assessment has the potential to affect the learning burnout of undergraduate students and enhance their learning effectiveness.

2.3 Learning Burnout

Learning burnout refers to the negative attitude and behavior of being bored with learning due to learning pressure or lack of learning interests (Meier & Schmeck, 1985). Burnout among students can have a negative impact on their academic achievement and personal well-being (Ribeiro et al., 2018). These findings suggest that addressing learning burnout is crucial for students' overall health as well as for their academic achievement.

A study reported that learning motivation and burnout have a significant negative correlation (Cazan, 2015). Current relevant research focuses on exploring the influencing factors of learning burnout from a psychological perspective and seeking intervention measures. An empirical study found that teachers' emotional support has a mitigating effect on learning burnout (Zhao et al., 2018). Based on existing relevant research, a lack of motivation is one of the causes of burnout (Felaza et al., 2020). Gamified assessment has been shown to stimulate motivation through the incorporation of gamification elements, immediate feedback, progress tracking, and healthy competition among students (Oliver, 2017; Pitoyo & Asib, 2020). Hence, the gamified assessment gives it potential to alleviate learning burnout considering learning motivation. Learning anxiety is an essential factor influencing learning burnout (Guangwen et al., 2013). The application of gamified assessment in traditional classroom teaching can effectively alleviate learners' learning anxiety (Lee et al., 2019). Hence, gamified assessment may indirectly help to alleviate learning burnout. Previous research has demonstrated that gamification can give learners pleasant psychological experiences like immersion and flow experiences, which could promote learning (Pitoyo, 2019; Watson et al., 2011). Gamification also places learners in a positive psychological state of learning, which has a positive impact on learners' academic achievement and engagement, thus alleviating learning burnout (Göksün & Gürsoy, 2019).

The above literature review highlights the negative relationship between learning motivation and burnout, giving gamified assessment the potential to affect learning burnout. The review also suggests that gamified assessment has the potential to alleviate learning burnout by stimulating motivation and promoting positive psychological experiences. This provides a basis for exploring if gamified assessment can affect the learning burnout of students. This study investigated such an issue among the computing undergraduates.

3. Methods

3.1 Theoretical Framework, Instrument and Intervention

Learning burnout can be measured with the Maslach Burnout Inventory-Student Survey, including three dimensions: emotional exhaustion, cynicism and low efficacy (Schaufeli et al., 2002). The scale is administered on a seven-point Likert scale ranging from 1 (absolutely inappropriate) to 7 (absolutely appropriate). Higher scores indicate higher levels of learning burnout. The study kept the structure of the original scale by referring to the Maslach Burnout Inventory-Student Survey. The questionnaire consists of 15 items divided into three dimensions above. Five items are designed to measure emotional exhaustion, which describes feelings of emotional depletion due to studying-related stress. Cynicism is measured with four items that assess negative attitudes and detachment towards studying, classmates, or teachers. Lastly, six items are employed to evaluate low efficacy, which refers to a diminished sense of competence and accomplishment in the realm of academics. The Learning Burnout Scale was translated into Chinese by a professional with expertise in educational psychology. Participants were provided with instructions in their native language and encouraged to seek clarification if needed. A pilot study was conducted to establish the validity and reliability of the translated version.

Empirical validation is necessary to confirm the hypothesized potential benefits of gamified assessments in reducing learning burnout. Nevertheless, the majority of research on learning burnout has been focused on medical students, which limits the potential for generalization of the observed findings (Almutairi et al., 2022; Fiorilli et al., 2022; Gradiski et al., 2022). All these points reveal the importance of this research. Based on the discussion above, the intervention in this study was guided by the theoretical framework presented in Figure 1 (Dicheva et al., 2015; Schaufeli et al., 2002).

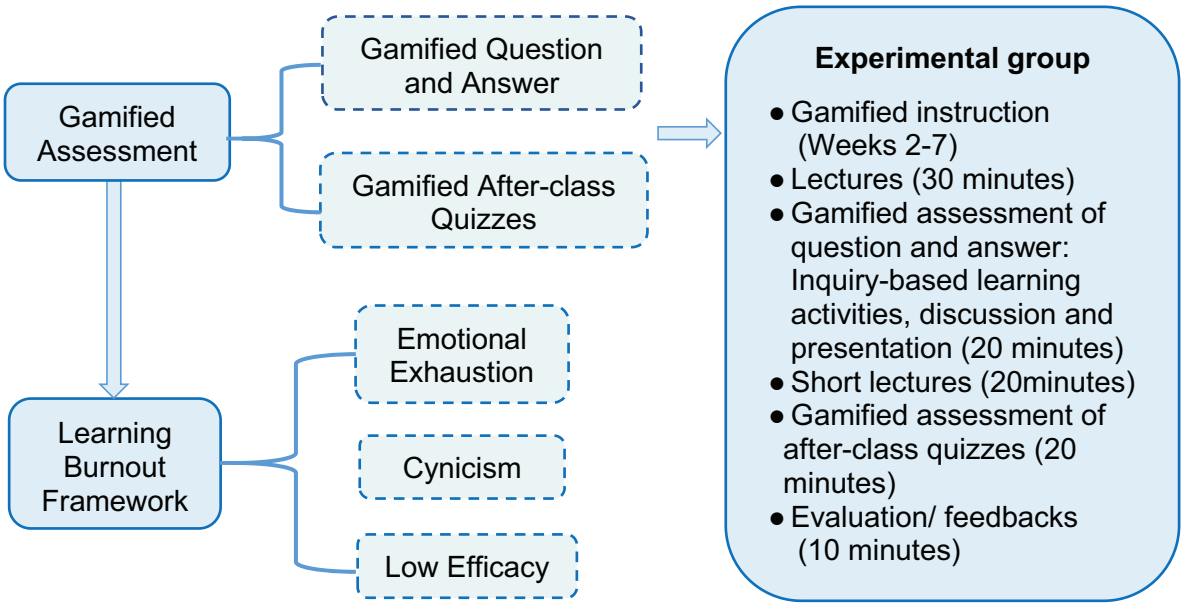

Figure 1. Alignment between the Theoretical Framework and Intervention

The targeted participants were recruited from 120 sophomores who majored in computing at a university in mainland China. There are two groups, including the experimental (n=60) and control groups (n=60). A weekly two-hour Java programming course was provided with or without gamified assessment for six weeks. The same computing instructor taught two classes under a similar instructional schedule for the purpose of controlling the conditions. However, the Java programming curriculum for the two groups had different instructional designs. The instructor taught the control group based on the traditional paper-and-pen assessment. Whereas for the experimental group, students learned under gamified assessment during class and finished gamified after-class quizzes by Quizizz. Overall, the experimental group was delivered instructions with the gamified assessment, while the control group continued to use the traditional assessment. The assessment tasks were balanced in terms of content and level of difficulty. Though learning with different approaches, participants in both the control and experimental groups received the same type of feedback, which included correct answers and explanations for each item after completing the assessment. One of the researchers was in charge of the gamified learning environment support, gamified learning design, and teachers training.

The research activities took place over a seven-week period and included preparation, intervention and assessment activities. Weekly-2-hours-activities of classes with gamified assessment for six weeks were designed by referring to the theoretical framework (Figure 1). For the experimental group, the students were introduced to the concept of gamification, the relevant platforms and the game elements in the first week. From week two to week seven, an intervention of teaching and learning activities took place and instructions were given on different topics of Java programming. The entire class was conducted in a gamified environment. While the control group was taught traditionally without gamified assessment. At the end of each lesson, students would take an after-class quiz.

3.2 Research Design and Data Collection Procedures

A quantitative approach with a pretest-posttest quasi-experimental design was used in this study (Figure 2). The implementation of gamified assessment consisted of two components: gamified question and answer sessions during class and gamified quiz sessions after class.

Quantitative data on burnout were collected by the Learning Burnout Scale (Schaufeli et al., 2002). Shortly before and after the intervention, the experimental and control groups took pretests and posttests of learning burnout. Averagely, it took about 5 minutes for participants to complete the questionnaires once, which were presented in electronic forms. During the data collection, students were given the e-questionnaire, and all the data was imported into SPSS as text files for data analysis.

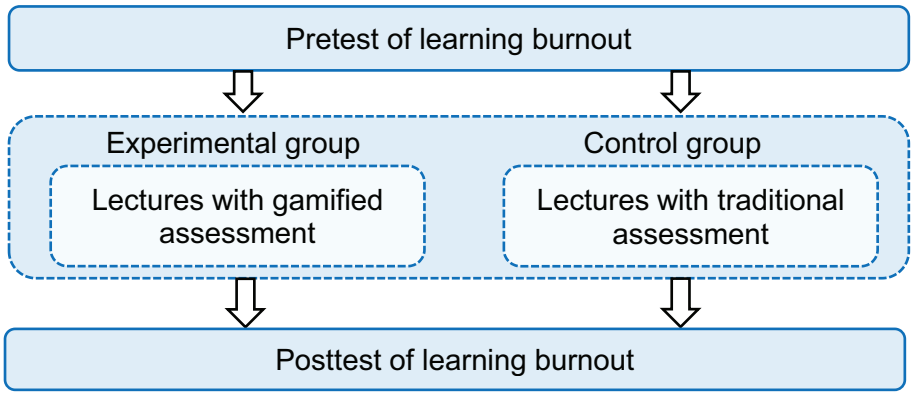

Figure 2. The Overall Research Design

3.3 Gamified Assessment Instructional Design

3.3.1 Gamified Question and Answer Sessions

The design of gamified question and answer sessions is shown in Table 1 based on the design of gamified assessment by Werbach et al. (Werbach et al., 2012). Regarding the possibility of student choice, the principle of "freedom of choice" was applied in this study (Dicheva et al., 2015). The principle of "social engagement" including individual and team competitions (Li et al., 2014) was applied when designing gamified question and answer sessions. Students could find information on all these gamified components in Moodle, allowing them to track their performance and progress over time.

Table 1. *The Design of Gamified Question and Answer Sessions (Werbach et al., 2012)*

Dynamics	Mechanics	Components
Emotions	Reward	Badges
	Competition	Badges, Leader Board
	Cooperation	Teams
	Resource Acquisition	Points
Progression	Feedback	Points, Badges, Leader Board, Levels
	Reward	Badges
	Resource Acquisition	Points
	Feedback	Points, Badges, Leader Board, Levels
Relationships	Cooperation	Teams

The five types of badges, "Active badge", "Courage badge", "Well done badge", "Challenge badge", and "Cooperation badge", were awarded to students based on their performance in learning (see Table 2 for detailed design). Each badge represented a particular achievement; students could collect them as they progressed through the assessment. The gamified assessment system implemented a point-based reward structure, providing immediate feedback for correct answers and thus promoting accuracy. This incentivization, combined with the opportunity for students to form collaborative teams,

facilitated not only individual learning but also collective achievement through the accumulation of points and badges. The visible leaderboard fostered a competitive environment and further motivated students to excel. The multi-tiered structure of the assessment, which featured escalating levels of difficulty and reward, was aimed at engendering students a sense of accomplishment, thereby inspiring continued learning progression.

Table 2. *Types and Descriptions of Badges Used in the Question and Answer Sessions*

Badge	Type	Description
	Active badge	When a student takes the initiative to answer a question, he/she would be given an “Active badge”.
	Courage badge	When a shy student answers a question for the first time, they would be given a “Courage badge”.
	Well done badge	When a student gives a perfect answer, a “Well done badge” would be awarded.
	Challenge badge	Questions would be classified as easy, medium and difficult levels. The student would receive a “Challenge badge” when he/she completes a difficult question. One “Challenge badge” is equivalent to 2 “Active badge”.
	Cooperation badge	During group tasks, if a group member shares a good suggestion for solving a problem, he/she would receive a “Cooperation badge”.

All these elements stated in Table 2 had the potential to mitigate student burnout by providing immediate feedback and incentives to motivate and engage students (Sailer & Sailer, 2021). Through teamwork and competition, the incorporation of gamification elements promoted interaction and support among students, increasing their self-confidence and ability to work together (Huang et al., 2019). Points, levels and different types of badges can decrease learning burnout by providing clarity of purpose and a sense of progressive achievement (Mekler et al., 2017).

3.3.2 Gamified Quizzes Sessions

Gamified quizzes were the process of transferring the after-class quizzes from the e-learning platform to the gamified assessment system (Delacruz, 2011). It meant using the existing gamified assessment system to conduct the after-class quizzes. The implementation of gamified assessment involved selecting a suitable system, creating questions, managing class data, and setting evaluation rules. An appropriate gamified assessment system was selected based on factors like functionality and cost. Assessment questions were created, which included a mix of multiple choice and judgement questions and scored out of 100. Class data was effectively managed to ensure the successful implementation of gamified assessment, and evaluation rules were established to ensure fair and accurate assessment.

Gamified quizzes sessions used Quizizz as a tool. Quizizz incorporates two distinct game modes: an assignment mode, which operates at a self-paced tempo, and a classroom mode, which follows a real-time, predetermined pace. The assignment mode was selected for this study to accommodate the learning needs of students after class. Furthermore, various gamification elements were integrated, including points, leaderboards, customizable avatars, auditory cues, countdown timers, and more.

3.4 Data Analysis

Using IBM SPSS 28.0, the quantitative data were analyzed. Cronbach's alpha was initially determined using the pretest data with the goal of guaranteeing internal consistency for every dimension of the Learning Burnout Inventory-Student Survey in the context of the research. Then, utilizing both pretest and posttest data, descriptive analysis and analysis of covariance were carried out to provide context as well as analyze the overall student learning burnout and each specific dimension between the experimental and control groups. The pretest scores of learning in two groups were considered in this study as factors that may have an impact on the posttest scores but are uncontrollable. Therefore, ANCOVA was used to modify posttest results for variables and remove these undesired consequences, with a confidence interval of 0.95. Participants' overall learning burnout level in the posttest and each dimension of it were the dependent variables, and the independent variable was "group" (the control group: group=0, the experimental group: group=1). All the basic ANCOVA assumptions were confirmed prior to the analysis. To examine the homogeneity of variance across the two groups, Levene's test was applied.

4. Results

Cronbach's alpha was determined using the pretest data to guarantee internal consistency for every dimension of the Learning Burnout Inventory prior to the posttest. All dimensions' Cronbach's alphas were more than .7 (α_{EX} = 0.871, α_{CY} = 0.939, α_{LE} = 0.818, α_{D} = 0.750), indicating that the Learning Burnout Inventory-Student Survey was a trustworthy instrument with internal consistency. The homogeneity of variance was assessed using Levene's test, and the findings (F_{EX} = 0.358, p > 0.05; F_{CY} = 0.469, p > 0.05; F_{LE} = 6.806, p < 0.05; F = 0.485, p > 0.05) indicated that, except from the dimension of low efficacy, there was no variation in the variances across groups. Then after conducting the Kruskal-Wallis test for low efficacy in two groups (P < 0.05), there was also a significant difference in low efficacy. The learning burnout pretest and modified posttest findings are analyzed by descriptive statistics and ANCOVA, as shown in Table 3. The results indicated that the overall learning burnout of the experimental group decreased significantly after the intervention.

Table 3. *Descriptive Statistics and ANCOVA Results of Learning Burnout*

Dimension	Pretest		Posttest		ANCOVA		
	Mean	SD	Mean	SD	F	P	η^2
Overall Learning Burnout							
Experimental Group	50.750	11.013	45.684[a]	11.057	13.315	< .001	.102
Control Group	52.683	13.346	53.566[a]	13.510			
Emotional Exhaustion (EX)							
Experimental Group	17.233	4.681	16.645[a]	5.105	.939	.332	.008
Control Group	17.033	6.281	17.605[a]	5.846			
Cynicism (CY)							
Experimental Group	13.417	4.886	11.204[a]	5.307	12.466	< .001	.096
Control Group	13.917	5.419	14.446[a]	1.677			
Low Efficacy (LE)							
Experimental Group	20.267	5.541	17.835[a]	3.988	17.016	< .001	.127
Control Group	21.700	5.564	21.515[a]	5.945			

Notes: Experimental Group (n = 60), Control Group (n = 60). The posttest has been modified based on the variables.

To determine whether there were any significant variations in overall learning burnout level and dimensions of learning burnout between the experimental and control groups in the

posttest, repeated measures of ANCOVA were carried out. Overall, students in the experimental group had a lower level of learning burnout than that of the control group, according to the results (Table 3) ($F = 13.315$, $P < .001$; $\eta^2 = .102$). In particular, the posttest revealed significant differences between the two groups on cynicism ($F = 12.466$, $P < .001$; $\eta^2 = .096$) and low efficacy ($F = 17.016$, $P < .001$; $\eta^2 = .127$). The first conclusion is that instructions with gamified assessment in computing curriculum have obviously alleviated the experimental group's overall learning burnout, especially in terms of cynicism (e.g., students have become less interested in studies since enrollment in the university) and low efficacy (e.g., students can effectively solve the problems that arise in studies). However, there was no significant difference in emotional exhaustion between the experimental and control groups according to the posttest scores. The second conclusion is that gamified assessment did not affect the learning burnout of undergraduate computing students in the emotional exhaustion dimension. Overall, the study found that gamified assessment affects the learning burnout of undergraduate computing students except the emotional exhaustion dimension.

5. Discussion and Conclusion

This study was a pretest-posttest quasi-experimental design to investigate the impact of gamified assessment on learning burnout. The findings of the study demonstrated that gamified assessment had a significant effect on alleviating the learning burnout of undergraduate computing students, particularly regarding cynicism and low efficacy, though no significant difference was manifested in emotional exhaustion. The beneficial effect of gamified assessment in undergraduate education is better recognized. Through instructional practices, it aided teachers in realizing the promising benefits of gamified assessment to alleviate overall and two out of three dimensions of student learning burnout.

The aforementioned results are in line with some research on gamified assessment in education (Dias, 2017; Hassan et al., 2021; Wang & Tahir, 2020; Zainuddin et al., 2020), suggesting that gamified assessment could alleviate burnout in the cynicism and low efficacy. In order to see how gamified assessment affects students' learning burnout positively or negatively in certain aspect(s), the subsequent stage of this project's qualitative research has been analyzing the data from student interviews. Academic performance, personality traits, study habits, and family background have all been proposed as potential moderators that could affect students' learning burnout. Another paper will present and discuss the related findings and conclusions.

The study included several limitations. Firstly, it is still unclear how learning burnout varies in different educational contexts. Future studies are expected to take different subjects' instructional and students' individual factors into consideration to draw a wider range of conclusions (Baydas & Cicek, 2019). Additionally, because the intervention only lasted six weeks, its impact on learning burnout may have been rather limited. With longitudinal experiments, further research can be done. Moreover, this study's sample size of 120 students was small, which might restrict the generalizability of research findings. By using more substantial sample sizes, the reliability can be improved. In addition to the previously mentioned limitations, it is crucial to recognize that language barriers may have caused difficulties for some participants in understanding the scale items. To address this potential issue, future studies could consider involving bilingual participants or conducting separate studies in different language contexts. Furthermore, the data collection mainly relied on self-reporting, which could make results relatively subjective and imprecise. It is possible to conduct extensive study utilizing a variety of tools, such as leveraging machine learning algorithms to assist in classroom observations and involving psychologists in assessing the level of student burnout. Despite the fact that significant differences were found in two out of three dimensions of learning burnout, their effect sizes were minimal (e.g., $\eta^2_{CY} = 0.096$), suggesting that the differences were not substantially significant (Cohen, 2013). There is still a need for more empirical studies investigating the effects of gamified assessment.

This is the first-stage quantitative study investigating the impact of gamified assessment on the learning burnout of undergraduate computing students. The findings of the second-stage qualitative study will explain how gamified assessment affects the learning burnout of undergraduate computing students. The further findings will be reported in another paper. After that, more comprehensive proposals for the incorporation of gamified assessment into tertiary education can be suggested.

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