Received: 3 May 2023 | Accepted: 30 June 2023

DOI: 10.1111/bjet.13361

ORIGINAL ARTICLE

British Journal of Educational Technology BERA

Intangible rewards versus tangible rewards in gamified online learning: Which promotes student intrinsic motivation, behavioural engagement, cognitive engagement and learning performance?

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Funding information
Research Grants Council, University Grants Committee, Grant/Award Number: 17616020

Abstract

Gamification has often been used to stimulate learner engagement via intangible rewards, such as virtual points and virtual badges, rather than material goods or benefits. However, not all learners value such intangible rewards; some express their desire to redeem intangible rewards for utilitarian resources or benefits. Although tangible rewards have long been considered a key gamification mechanism in commercial loyalty programs, few studies have explicitly explored its effectiveness in the context of gamified education. To address this gap, the present study used a randomized controlled trial approach to examine the effects of tangible rewards that are redeemed through intangible rewards on students' intrinsic motivation, behavioural and cognitive engagement, and learning performance in a fully online gamified flipped class. Each student was randomly assigned either to the tangible rewards group (EG = 28) or the intangible rewards group (CG = 29). The students in EG significantly outperformed those in CG in terms of intrinsic motivation, behavioural engagement, cognitive engagement and learning performance in the final exam. The results provided practical implications for instructors who plan to use tangible rewards in their gamified classes.

KEYWORDS

engagement, gamification, intrinsic motivation, redeem, rewards

Practitioner notes

What is already known about this topic

- Fully online learning often suffers from a lack of student engagement.
- Gamification is often used to stimulate learner engagement via intangible rewards (eg, virtual points and badges) that do not contain any utilitarian benefits outside the gamified system.
- Not all learners value intangible rewards over time—instead, they desire to convert the intangible badges or points into more utilitarian benefits/resources.

What this paper adds

- This study conducted a randomized controlled experiment to compare the effects of redeemable tangible rewards and intangible rewards on student intrinsic motivation, behavioural engagement, cognitive engagement and learning performance.
- The tangible rewards group significantly outperformed the intangible rewards group in all aspects.

Implications for practice

- Using tangible rewards is better than merely using intangible rewards in gamified learning.
- Practitioners should link tangible rewards to a standard of performance.
- Practitioners should also set a specific and moderately challenging redemption goal.

INTRODUCTION

Although online learning provides students with the convenience of attending lessons in the comfort of home and flexibility in scheduling, online students have reported a lower level of engagement than face-to-face learning (Cavinato et al., 2021; Francescucci & Rohani, 2019). Gamification, the process of applying game elements to non-game contexts, has been used to promote greater student engagement (Bai et al., 2021) and performance (Lo & Hew, 2020) in online learning.

Rewards are commonly used in gamification to incentivize participants (Nicholson, 2015). Rewards can take two forms: tangible and intangible. Tangible rewards involve material goods or utilitarian benefits (eg, money, access to preferred activities) (Cameron et al., 2001; Kappen & Orji, 2017). Intangible rewards (eg, virtual badges) do not offer material or utilitarian benefits to recipients (Meder et al., 2018).

Tangible rewards, usually redeemed through accumulated points, are commonly used to increase customer expenditure in gamified commercial programs (Gabel & Guhl, 2021). However, in education, intangible rewards (eg, virtual badges) that do not contain utilitarian benefits outside the gamified system are more commonly used (Bai et al., 2021; Meder et al., 2018). While these non-utilitarian rewards may elicit pleasurable experiences in gamified courses (Landers et al., 2015), not all learners value them over time—instead, they prefer to exchange such rewards for utilitarian or material resources (Huang & Hew, 2018).

Nevertheless, the merit of tangible rewards in promoting intrinsic motivation and behaviour in students has long sparked controversy and remains up for debate (Kappen & Orji, 2017; Murayama, 2018). To shed more light on this controversy, this study compared the effects of intangible and tangible rewards on students' intrinsic motivation, behavioural and cognitive engagement and learning performance in a fully online gamified flipped class. ‘Intrinsic motivation’ refers to students' perceived interest/enjoyment in doing an activity. ‘Behavioural engagement’ refers to students' participation in course activities (eg, answering questions) (Fredricks et al., 2004). ‘Cognitive engagement’ refers to students' willingness to expend effort to comprehend complex subject contents (Rotgans & Schmidt, 2011) (eg, students' self-regulation and learning strategies) (Fredricks & McColskey, 2012). Students' learning performance refers to their final exam scores.

LITERATURE REVIEW

Contradictory theoretical and empirical evidence

Theories regarding tangible rewards in education offer divergent standpoints. On the one hand, Deci (1971) reported that students rewarded with money for completing puzzle tasks were less motivated to continue working on the task than those who received no money. Based on these findings, Deci et al. (1975) posited that tangible rewards harm students' intrinsic motivation. Cognitive evaluation theory (CET) argues that tangible rewards are perceived as controlling (students being forced to complete designated tasks) instead of informational (students being informed of personal performance). Deci et al. (1999, 2001) subsequently concluded that tangible rewards significantly undermine both free-choice behaviour and self-reported interest. Popularization of this theory eventually fostered negative attitudes towards using tangible rewards to promote desirable motivation in learning (Cameron et al., 2001).

On the other hand, Eisenberger and Cameron (1996) argued that tangible rewards do not harm intrinsic motivation. Cameron et al. (2001) meta-analysed 145 studies and found that the detrimental effects of tangible rewards only occur under highly restricted, easily avoidable conditions, such as when the tangible reward is offered without regard to any absolute or relative performance standard.

In contrast, when tangible rewards are linked to the learner's level of performance (eg, surpassing a particular score or others' performance), students' free-choice behaviour is either significantly increased or does not differ from unrewarded students (Cameron et al., 2001). According to social cognitive theory, rewards related to certain levels of performance (eg, exceeding a certain score or surpassing other people's scores) can enhance an individual's perceived competence or self-efficacy (Bandura, 1986). Greater self-efficacy can lead to higher interest in a task and to more time spent on the activity (Cameron et al., 2001). Additionally, according to learned industriousness theory (Eisenberger, 1992), the feeling of high effort reinforced by tangible rewards may function as a secondary reinforcer to stimulate readiness to expend effort in goal-directed tasks. Thus, if tangible rewards are used in an appropriate way, for example by informing students how their performance compares with others or by setting explicit goals for them, students' intrinsic motivation and engagement are not harmed.

Related work

Most studies on gamification rewards in online learning have focused on the intangible form (Bai et al., 2021; Meder et al., 2018), with mixed results. Several studies reported that intangible game elements improve students' cognitive engagement and promote higher-quality academic work (Huang & Hew, 2018; Jong et al., 2018). However, other studies reported that intangible game elements have no impact on student learning (Gafni et al., 2018) or even lower learning performance (Metwally et al., 2021). One possible reason for these contradictory findings is that not all learners are enthusiastic about intangible rewards. Some learners complained that intangible gamification rewards (eg, virtual points) were meaningless (Diefenbach & Müssig, 2019) and expressed a desire to convert them into actual course grades (Huang & Hew, 2018).

Only a few studies have directly compared the use of tangible and intangible rewards in gamified education. Ortega-Arranz et al. (2019), for example, compared students' behavioural engagement in an MOOC course between a 'gamified group' rewarded with virtual badges only, a 'tangible-reward-gamified-group' awarded with virtual badges that could be used to redeem certain learning benefits (eg, access to supplementary content), and a control group without game elements and tangible rewards. Although both the gamified group and the tangible reward group outperformed the control group, no significant difference was found between the two groups. The study did not examine the effects of tangible rewards on students' intrinsic motivation or cognitive engagement. Additionally, there is a considerable difference between MOOC and conventional online courses. Many MOOC learners do not intend to finish the course but to fulfil other needs (eg, refresh their memory of certain topics) (Davis et al., 2017). Thus, the results of Ortega-Arranz et al. (2019) may not be relevant to non-MOOC online courses.

More recently, Bai et al. (2021) compared online students who received virtual points with online students who received virtual points with tangible rewards (the top five students on the leaderboard, and the five students whose performance improved the most over the previous week were given samples of last year's class assignments). While game elements with tangible rewards appeared to motivate the students to participate more, no significant difference was found in their learning performance. The study did not examine the possible effects of tangible rewards on students' intrinsic motivation.

Purpose of the present study

This study examines the effectiveness of tangible rewards on fully online students' intrinsic motivation, behavioural engagement, cognitive engagement and learning performance, using a randomized controlled study design. Randomized controlled studies are often considered a rigorous method of establishing whether a cause-and-effect relationship exists between a treatment and the focal outcome (Farrokhyar et al., 2010). By random allocation, the bias of systematic differences can be reduced (Bhide et al., 2018). Any observed differences in outcomes between the groups can be attributed to the intervention rather than other factors (Bhide et al., 2018).

The study was guided by the following research questions (RQs):

RQ1: What are the effects of intangible and tangible rewards on students' intrinsic motivation?

RQ2: What are the effects of intangible and tangible rewards on students' behavioural engagement?

RQ3: What are the effects of intangible and tangible rewards on students' cognitive engagement?

RQ4: What are the effects of intangible and tangible rewards on students' learning performance?

METHODOLOGY

Context and participants

This study involved 57 higher education participants with an average age of 21. The participants were enrolled in a fully online international business course, which comprised eight sessions lasting 3.5 hours each. Each student was randomly assigned to either the control group (CG) (intangible rewards, $N=29$) or the experimental group (EG) (tangible rewards, $N=28$). This course prepared students for the National Postgraduate Entrance Examination (NPEE), an annual examination usually taken by students during their last year of university. Students planning to enter an international business master's degree program by taking the NPEE signed up for this course voluntarily.

The course was delivered in a fully online mode using the gamified flipped instructional approach. The only difference between the two groups was that the EG students could redeem their accumulated virtual points for extra learning materials, while the CG students could not (see Section "Instructional Design of the Class and the Redemption Scheme" for details). The extra learning materials were sample answers to additional questions related to each session's course topic on international business. To avoid possible bias introduced by different instructors (eg, different teaching styles), the same instructor taught both groups. The instructor was not informed which was the EG or CG and the researcher was not involved in teaching either group. Ethical approval for data collection and student consent were obtained in advance. To avoid possible ethical issues, all the redeemable rewards were given to the CG students *after* the experiment ended.

Instructional design of the class and the redemption scheme

A typical flipped class comprises two major components: pre-class work and in-class interactive learning (Bishop & Verleger, 2013). In this study, we conducted the fully online flipped class via a synchronous videoconferencing tool to support in-class learning activities.

We drew on Merrill's (2002) First Principles of Instruction to design the fully online flipped class. Merrill (2002) identified five principles of effective instruction (problem solving, activation, demonstration, application and integration), and organized them into a sequence of instructional phases centred around problem solving.

Specifically, for the online pre-class activities, the principles of activation and demonstration were used. Short instructional videos (Förster et al., 2022) or reading materials (Lai & Hwang, 2016) were prepared to help the students recall the necessary background knowledge (activation) and to introduce basic knowledge (demonstration) for the new learning topic of each session. The students were given five multiple-choice questions requiring them to recall what they had learned from the pre-class materials. For the online in-class activities, all five principles were applied. Each session targeted real-world problem solving related to business (eg, conducting market analysis for a company planning to expand internationally) (problem-centred). The instructor briefly reviewed the pre-class learning materials and explained the quizzes based on students' performance. Then, the instructor illustrated the advanced learning content (demonstration). The students then applied what they had learned to solve problems and shared how they solved the problems (application and integration). At the end of each session, the students were given a short quiz comprising 10 multiple-choice questions to assess their recall of the learning content (Figure 1).

Points–badges–leaderboards (the PBL triad), together forming one of the most frequently used gamification elements (Leitão et al., 2022), were used in both groups. The gamification rewards (points and badges) were contingent on task completion and performance.

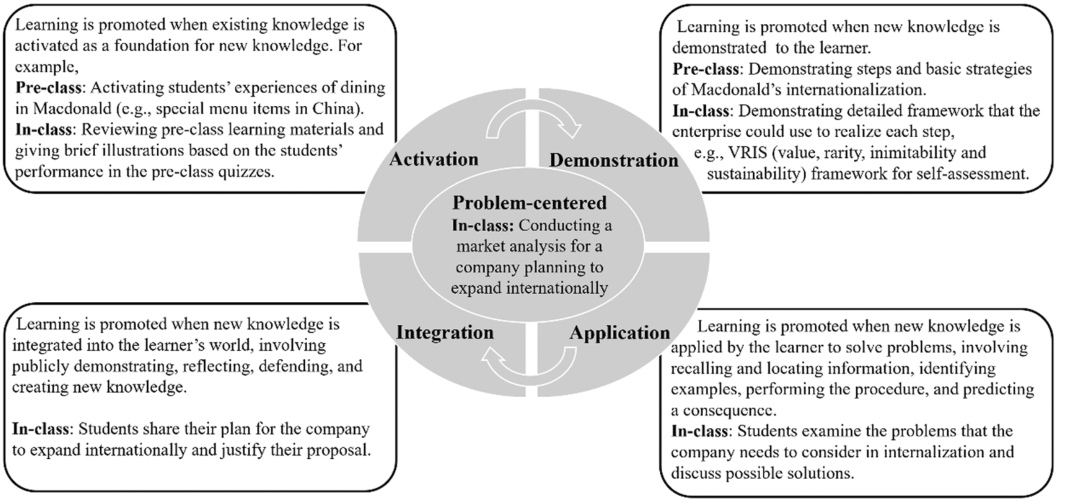

FIGURE 1 Fully online flipped classroom design grounded in the first principles of instruction (adapted from Merrill, 2002, p. 45).

Performance-contingent rewards were given more weight than completion contingent rewards, as they can improve students' intrinsic motivation (Cameron et al., 2001) and increase student engagement (Park et al., 2019).

Specifically, for each correct answer in the pre-class and in-class quizzes, a student was given 10 points. A maximum of 150 points could be earned for good performance in each session's quizzes. *Fully Prepared* and *Quiz Whiz* badges were awarded to students whose accuracy rate was higher than 80% in the pre-class and in-class quizzes, respectively. Furthermore, five points were awarded for the first successful download of pre-class learning materials for each student, and five points were awarded for the completion of the pre-class tasks of downloading the pre-class materials and completing the pre-class quiz. *Task Completion* and *Task Master* badges were awarded for the completion of the pre- and in-class quizzes, respectively. Ten points were awarded for each voluntary response to the instructor's question as well as for each voluntary posing of questions to the instructor (with a limit of three responses or questions), for a maximum of 40 points that a student could earn for these completion tasks in each session. The students' overall ranking based on their accumulated points was presented on the leaderboard.

Additionally, the students in the EG could redeem their accumulated points each week for tangible rewards. The tangible rewards constituted extra course materials (eg, sample answers to additional questions related to each session's course topic). The tangible rewards were updated according to each session's learning topic. At least 160 points (approximately 80% of the maximum number of points) were needed to redeem the tangible reward each week. This threshold was considered a difficult but attainable goal by the course instructor and researcher. Most participants (70%) in the EG agreed with the statement 'I think the goal of redemption is difficult but attainable'. The redemption rules were explained to the students before the course started. Appendix A elaborates how Merrill's (2002) First Principles and the game elements were applied in the class.

Data collection and analysis

The following data were collected to analyse student engagement and intrinsic motivation: task completion rate, test scores and questionnaire responses (Appendix B).

The effects of rewards on the students' intrinsic motivation (RQ1) were measured by the intrinsic motivation subscale from the Situational-Motivation-Scale (SIMS; Guay et al., 2000). The intrinsic motivation scale focuses on students' perceived interest/enjoyment in an activity. Following Zhou (2016) and Lai et al. (2021), we adapted items from the SIMS by making them specific to the learning context of this study. The Mann–Whitney *U* test was conducted to compare the CG's and EG's SIMS responses.

The effects of rewards on the students' behavioural engagement (RQ2) were measured by the number of students who had completed the pre-class and in-class tasks *before* the weekly deadline, that is, those who received the weekly *Task Completion* badge and *Task Master* badge. The pre-class tasks required the students to read the pre-class materials or watch videos related to the basic information of the course content, and then answer five corresponding multiple-choice questions. A student's completion of all of the pre-class tasks, regardless of accuracy, was rewarded with the *Task Completion* badge. The in-class tasks, short quizzes comprising 10 multiple-choice questions and completed by the end of each session, aimed to assess students' understanding of the course topics. A student's completion of an in-class assessment, regardless of accuracy, was rewarded with the *Task Master* badge. Chi-square tests were conducted to test whether there was a statistically significant difference in task completion rates between the CG and EG.

The effects of rewards on the students' cognitive engagement (RQ3) were evaluated by the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991). The MSLQ was selected because it is commonly used for measuring cognitive engagement (Greene, 2015), comprising the most comprehensive set of self-regulatory strategies specifically for undergraduate students, with robust scale reliability and validity (Broadbent, 2017; Pintrich et al., 1993). We chose the metacognitive self-regulation strategies subscale ($\alpha = 0.79$), as it fits the concepts of cognitive engagement explored in this study. Metacognitive self-regulation strategies help to regulate and control cognition to accomplish a goal, including strategies such as goal setting, planning and self-monitoring. Altogether, seven items were adapted from the selected scales. An independent *t* test was conducted to compare the CG and EG students' MSLQ responses.

The effects of rewards on students' learning performance (RQ4) were evaluated by comparing their final exam scores and weekly quiz scores. We administered a knowledge test to examine the initial differences in the students' relevant knowledge levels before the course started. At the end of the course, the students were given a final exam (maximum 150 marks), and their scores were used to measure their learning performance, which was an objective measurement of students' efforts in learning. Analysis of covariance (ANCOVA) was employed to compare the CG students' final exam scores with those of the EG students after controlling their prior knowledge. In addition, the MCQ questions in the pre-class and in-class quizzes mainly assessed students' recall of factual knowledge. Student's performance in the weekly quizzes was also reported as a measure of their learning performance. The Mann–Whitney *U* tests were conducted to compare the CG and EG students' weekly quiz scores.

RESULTS

Intrinsic motivation

The students' intrinsic motivation, measured by the intrinsic motivation subscale from the SIMS, had very good reliability in this study (Cronbach's alpha = 0.952). The Shapiro–Wilk statistics showed a normal distribution of student responses in the CG ($W = 0.946$, $p = 0.145$), while it showed a non-normal distribution in the EG ($W = 0.827$, $p = 0.000$) in terms of intrinsic motivation. Accordingly, students' responses to this scale were examined using the Mann–Whitney *U* test. Students in the EG ($Mdn = 6.333$) had a significantly higher degree of intrinsic motivation than the CG ($Mdn = 5.000$, $U = 614.500$, $p < 0.05$, $r = 0.446$).

Thus, the results suggest that students who could redeem tangible rewards had a significantly higher level of intrinsic motivation than those who received only intangible rewards.

Behavioural engagement

Pre-class task completion

The EG's completion rate was higher than that of the CG throughout all eight sessions, although the difference was slight in Week 3 (Figure 2). Both groups witnessed a decrease from Week 1 to Week 3. However, the completion rate of the EG held relatively steady and high, while that of the CG dropped drastically. By the end of the course, only 34% of the students in the CG had completed the pre-class tasks, whereas 79% of the EG had completed the tasks.

Considering the increased probability of Type I errors associated with conducting multiple Chi-square tests, the Sidak-Bonferroni procedure was employed to determine an adjusted alpha level of 0.006 (Table 1). By comparing the *p* values obtained from the Chi-square tests to the adjusted alpha of 0.006, rather than the typical 0.05, it was observed that some results no longer showed statistical significance (W1, W2 and W5). However, the significantly higher pre-class task completion rate in EG than in CG still held true in the latter half of the course (four out of the last 5 weeks). In general, the results indicated a clear trend that the EG students were significantly more likely to complete the pre-class tasks than the CG over time.

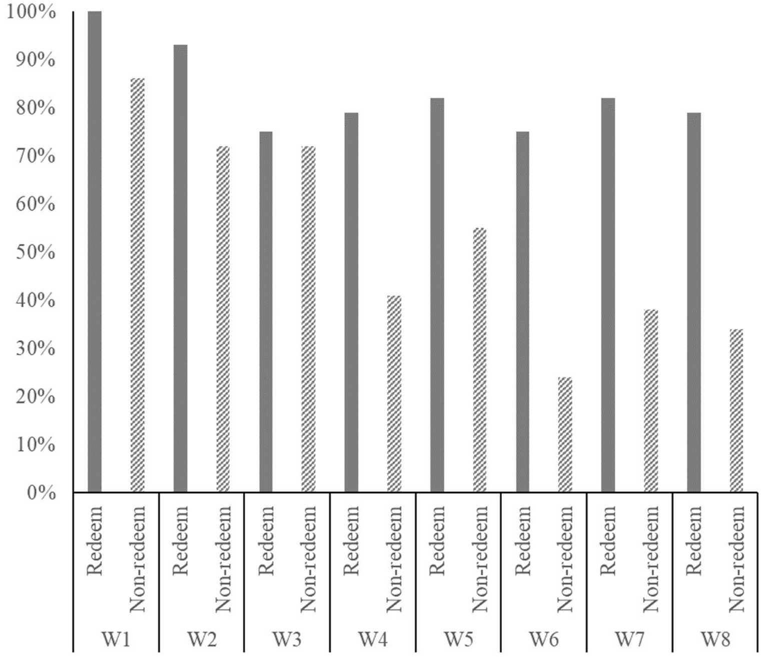

FIGURE 2 Pre-class tasks are completed before weekly deadlines. 'Redeem' refers to EG, and 'non-redeem' refers to CG.

TABLE 1 Pre-class task completion.

Week	Condition	Completed before deadline (%)	Chi-square
W1	EG	100	$\chi^2=4.154$, $p=0.042$*
	CG	86	
W2	EG	93	$\chi^2=4.116$, $p=0.042$*
	CG	72	
W3	EG	75	$\chi^2=0.049$, $p=0.825$
	CG	72	
W4	EG	79	$\chi^2=8.187$, $p=0.004$**
	CG	41	
W5	EG	82	$\chi^2=4.796$, $p=0.029$*
	CG	55	
W6	EG	75	$\chi^2=14.746$, $p=0.000$**
	CG	24	
W7	EG	82	$\chi^2=11.569$, $p=0.001$**
	CG	38	
W8	EG	79	$\chi^2=11.246$, $p=0.001$**
	CG	34	

Note: *W3*, a public holiday occurred during this week.

**Significant using an adjusted alpha of 0.006 (Bonferroni adjustment); *Significant using $p<0.05$, not significant using Bonferroni adjustment.

In-class task completion

Figure 3 indicated that a higher proportion of students in the EG completed the in-class quizzes than the CG, in all eight sessions. Although the gap between the two groups was mitigated in Week 3, it remained drastic for the remaining sessions.

Chi-square tests of independence showed statistically significant differences between the EG and CG in terms of the completion rate of in-class quizzes, except for weeks 2–3 (Table 2). In general, the EG students were significantly more likely to complete the in-class quizzes than the CG, particularly in the last five sessions of the course.

In summary, the results suggest that students who can redeem virtual gamification rewards for tangible rewards have a significantly higher level of behavioural engagement than those who cannot over time.

Cognitive engagement

Students' cognitive engagement was measured using the self-regulation strategies subscale from the MSLQ with relatively good reliability (Cronbach's alpha = 0.70). The response rate for the questionnaire was 100%. The Shapiro–Wilk statistics showed a normal distribution of student responses in both the EG ($W=0.936$, $p=0.086$) and CG ($W=0.979$, $p=0.824$) in terms of self-regulation strategies. Accordingly, students' responses to this scale were examined using an independent t test. The EG students ($M=5.821$, $SD=0.780$) reported a significantly higher level of metacognitive self-regulation strategies than the CG ($M=5.286$, $SD=0.713$), $t(55)=2.707$, $p=0.009$, BCa 95% CI [0.139, 0.932], $d=0.716$.

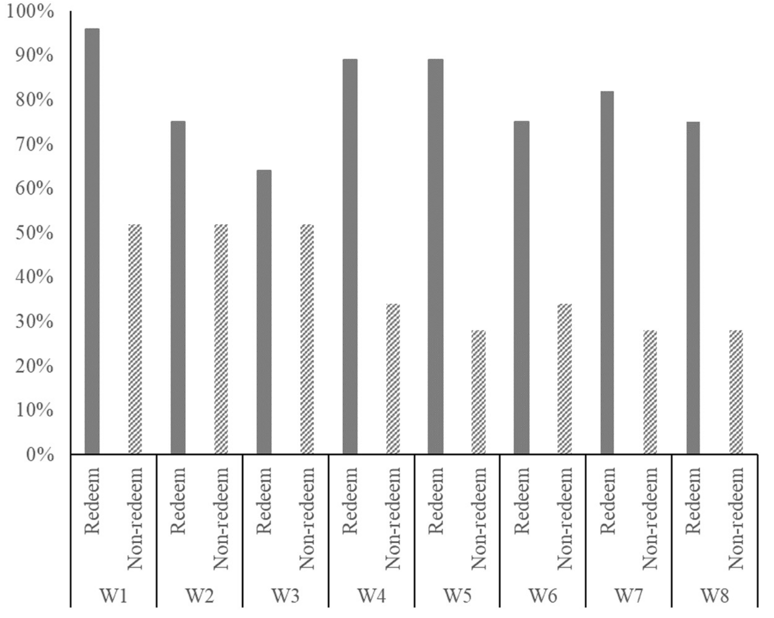

FIGURE 3 In-class tasks completed before weekly deadlines.

In summary, the results suggest that students given tangible rewards have a significantly higher level of cognitive engagement than those given intangible rewards.

Learning performance

Final exam score

All the students participated in the knowledge test before the course started, while three of the students in the CG did not participate in the final exam. Our comparison of students' learning performance was based only on the scores of those who participated in both tests ($n=54$).

The Shapiro–Wilk test was conducted on the scores in the knowledge test before the course stated, and the resulting statistics indicated a normal distribution of the scores in the EG (W = 0.982, $p=0.894$) and CG (W = 0.967, $p=0.538$). Correspondingly, an independent *t* test was conducted to examine the students' *prior* knowledge as measured by this test. No significant difference was found between the EG ($M=102.107$, $SD=21.472$) and CG ($M=93.192$, $SD=24.357$), $t(52)=1.429$, $p=0.159$, 95% CI [−3.603, 21.433].

We employed ANCOVA to compare the differences in final exam scores between the two groups. It was found that there was a significant effect of tangible rewards on students' performance in the final exam after controlling for their prior knowledge, with a medium to large effect size, $F(1, 51)=4.669$, $p=0.035$, partial $\eta^2=0.084$ (Cohen, 1969). EG students ($M=100.679$, $SD=15.011$) performed better than the CG ($M=87.231$, $SD=22.004$) in the final exam.

Weekly quiz scores

The weekly pre-class and in-class quizzes were conducted in the form of online multiple-choice questions. The main purpose was to assess students' factual knowledge of the

TABLE 2 In-class quiz completion.

Week	Condition	Completed before deadline (%)	Chi-square
W1	EG	96	$\chi^2=14.682$, $p=0.000$**
	CG	52	
W2	EG	75	$\chi^2=3.371$, $p=0.069$
	CG	52	
W3	EG	64	$\chi^2=0.922$, $p=0.337$
	CG	52	
W4	EG	89	$\chi^2=18.053$, $p=0.000$**
	CG	34	
W5	EG	89	$\chi^2=22.247$, $p=0.000$**
	CG	28	
W6	EG	75	$\chi^2=9.427$, $p=0.002$**
	CG	34	
W7	EG	82	$\chi^2=17.092$, $p=0.000$**
	CG	38	
W8	EG	75	$\chi^2=12.814$, $p=0.000$**
	CG	28	

Note: *W3*, a public holiday occurred during this week.
**Significant using an adjusted alpha of 0.006 (Bonferroni adjustment).

particular week's content. The scores of both EG and CG were collected and analysed. For both groups, the scores for students who did not complete a quiz were handled as missing data. Mann–Whitney *U* tests were administrated to examine if there were statistically significant differences between the quiz scores of EG and CG since Shapiro–Wilk test statistics showed non-normal distributions of scores. As seen in Table 3, there were no significant differences in the two groups' scores across all eight class sessions.

DISCUSSION

Effect on students' intrinsic motivation

We found that tangible rewards had a significant and positive influence on students' intrinsic motivation as measured by their perceived interest and enjoyment in performing an activity.

This finding suggests that tangible rewards, under certain conditions, enhance people's intrinsic motivation. In this study, tangible rewards were earned by meeting or exceeding absolute standards of performance, which can lead to increased task interest and enjoyment. Several theoretical views may account for the positive effects of tangible rewards on intrinsic motivation, mostly from the perspective of improved competence or self-efficacy as perceived by the learner. Specifically, tangible rewards, if tied to certain levels of performance, contain more informational values, which can offset the negative influence of the controlling aspect (ie, the student's perception of being manipulated, as described above) (Cameron et al., 2001). In this study, each redemption delivered positive feedback to strengthen the students' feelings of competence, which is a key component of intrinsic motivation, according to self-determination theory (Ryan & Deci, 2000). Lepper et al.'s (1996) extension of the

TABLE 3 Weekly pre-class and in-class quiz scores.

Week	Condition	Pre-class (Mdn)	Mann–Whitney *U* test	In-class (Mdn)	Mann–Whitney *U* test
W1	EG	50.000	U=388.500, p=0.432	90.000	U=245.500, p=0.234
	CG	50.000		90.000	
W2	EG	45.000	U=234.000, p=0.352	100.000	U=210.500, p=0.089
	CG	50.000		90.000	
W3	EG	50.000	U=252.000, p=0.529	90.000	U=143.000, p=0.789
	CG	50.000		90.000	
W4	EG	40.000	U=136.000, p=0.804	90.000	U=160.500, p=0.198
	CG	40.000		80.000	
W5	EG	50.000	U=273.500, p=0.049	100.000	U=136.500, p=0.127
	CG	40.000		90.000	
W6	EG	50.000	U=74.500, p=0.661	90.000	U=152.500, p=0.043
	CG	50.000		80.000	
W7	EG	50.000	U=169.500, p=0.114	100.000	U=110.500, p=0.411
	CG	40.000		90.000	
W8	EG	50.000	U=147.000, p=0.140	100.000	U=95.500, p=0.582
	CG	45.000		90.000	

attribution theory reflects a similar idea, namely that tangible rewards based on performance levels increase perceived competence, which directs attributions of causation toward the self. This, in turn, leads to increased intrinsic motivation to perform an activity. Furthermore, as mentioned above, Bandura's (1986) social cognitive theory emphasizes the significance of increased self-efficacy to increased task interest.

In addition, the tangible reward used in this study (ie, sample answers to additional questions related to international business) has utility value to the students. Utility value is the perception that doing a task (ie, earning the tangible reward of sample answers) will help students achieve a future goal (Husman et al., 2004).

Although there is a debate that motivation generated by perceptions of utility value is extrinsic (Ryan et al., 1996), it is crucial for us to differentiate between two types of utility value—exogenous instrumentality and endogenous instrumentality (Husman et al., 2004). Unlike the former, endogenous instrumentality is the perception that accomplishing a present task is inherently related to the individual's future goal (Husman & Lens, 1999). Endogenous instrumentality supports intrinsic motivation because it helps individuals gain competence in learning (Husman et al., 2004).

The tangible rewards in our study have endogenous instrumentality value because they were personally relevant to students as the rewards were closely related to the students' future goals of entering their desired business school to embark on a career in the field of international business. This connection promoted students' intrinsic motivation, which is consistent with their self-reported intrinsic motivation scores. Satisfaction of intrinsic motivation can also sustain behavioural engagement (Plass et al., 2020), as reported in the following section.

Effect on students' behavioural engagement

Although the difference between EG and CG was not statistically significant in earlier weeks, it could still be concluded that awarding students with redeemable tangible rewards significantly increased their behavioural engagement as measured by the completion rate of pre-class tasks and in-class quizzes over time. The initial relatively high task completion rates in both groups might be caused by the novelty effect—a phenomenon that people temporarily behave actively when exposed to a new or novel stimulus, and reduce that behaviour when the novelty wears off (Rodrigues et al., 2022). After the public holiday in Week 3, the task completion rates in EG remained higher than those in CG in most of the later sessions, indicating the positive influence of tangible rewards on students' behavioural engagement over time.

Effect on students' cognitive engagement

We found that tangible rewards also significantly increased students' cognitive engagement as measured by their self-reported metacognitive self-regulation strategies.

This positive influence may be explained by goal setting theory, according to which the setting of appropriate goals is beneficial for developing good self-regulation skills (Latham & Locke, 1991). Whether goals are appropriate is determined by two key attributes, namely specificity and difficulty. The redemption rule in this study established a specific and challenging weekly goal for the students. To successfully redeem for the tangible rewards (achieve the goals), the students were required to self-regulate their learning for the entire week, for example by planning how many badges to strive for, monitoring how many points they still needed, and adjusting their performance to reduce the discrepancy between their actual performance and the desired goals. Importantly, this weekly goal was not too difficult to attain according to both the instructor and the students.

However, our findings are inconsistent with Bai et al. (2021), who also used useful learning materials as tangible rewards, and reported that the presence of tangible rewards has no impact on students' learning performance. Such conflicting results may be explained by expectancy value theory (EVT) (Vroom, 1964). According to EVT, one's expectancy for achieving a goal is a crucial driving force for task performance. In the study of Bai et al. (2021), only the top *five* students on the leaderboard and the *five* students whose performance improved the most each week could receive a tangible reward. This can lower the other participants' expectancies of receiving the reward and, for that reason, exert no influence on their learning performance. In our design, no limitation was set regarding the number of winners of the tangible rewards, meaning that every participant had a chance to successfully redeem for what they want.

Effect on students' learning performance

We found that the redeemable tangible rewards had a significant and positive influence on students' final exam scores, but had no significant effects on their weekly quiz scores.

The positive influence on students' final exam scores could be explained by the goal setting theory. The goal serves as a benchmark for excellent performance, enabling people to evaluate their own performance and identify areas for improvement in order to bridge the gap between their actual performance and the desired goal (Latham & Locke, 1991). Specific and challenging goals consistently lead to better performance than vague but challenging goals, such as 'do your best', vague and unchallenging goals or a lack of goals (Locke, 1968; Locke & Latham, 1990). Although intangible rewards such as badges may also provide goals for students (Huang et al., 2019), redeemable tangible rewards provide more challenging goals. In this case, after 8 weeks of intervention, students who could redeem tangible rewards significantly outperformed those who could not in the final exam.

The weekly pre-class and in-class quizzes mainly tested learners' recall of simple facts and concepts covered in a particular week (ie, factual knowledge), while the final exam required students to engage in more challenging tasks such as analysing the problems, evaluating the information, justifying a stand and formulating a solution. This indicates that the difference in students' learning performance may be mostly observed in more challenging tasks (Huang et al., 2019).

Practical implications

The findings of this study indicate that using tangible rewards can be better than merely using intangible rewards in gamified learning. Intangible rewards in gamified learning are not motivating to all learners. In particular, adult learners in higher education prefer tangible rewards that carry utilitarian benefits (Diefenbach & Müssig, 2019; Huang & Hew, 2018). Both the reward scheme and the reward type are crucial to the effectiveness of tangible rewards in promoting desirable learning outcomes (Bai et al., 2021). Following the findings, we provide several suggestions for the future implementation of gamification in online classes to better address student disengagement. These are detailed below:

Linking tangible rewards to a standard of performance

The negative reputation of tangible rewards is mainly due to CET (Deci, 1971) and the overjustification hypothesis (Lepper et al., 1973), which proposes that a person's intrinsic motivation to engage in an activity may be decreased by inducing them to engage in that activity as an explicit means of achieving an extrinsic goal. However, tangible rewards do not deserve their bad reputation; rather, studies have overinterpreted nonsignificant results as indicating a significant negative influence (Cameron & Pierce, 2002). In fact, tangible rewards can be helpful if used appropriately, the key being to link them to a standard of performance. Such tangible rewards not only set goals for students but also provide informational feedback regarding their learning performance. When students redeem for tangible rewards by themselves, their self-efficacy is boosted.

Setting a specific and moderately challenging redemption goal

If a redemption goal is ambiguous or easy, students may not maximize their efforts to realize it due to inaccurate judgements about their own performance (Kernan & Lord, 1989). In a study of more than 100 tasks involving more than 40,000 participants, providing specific and challenging goals improved task performance in terms of both quantity and quality (Locke & Latham, 2002). However, performance levels off or decreases when the limits of students' abilities are reached (Erez & Zidon, 1984). This is because goal difficulty is closely related to the probability of success. If students' expectancies for successful redemption are impeded, their motivation to continue learning is lowered, as is their learning performance. Therefore, it is important that redemption goals be perceived as attainable by most students.

Setting personalized rewards and giving students the autonomy to redeem

Tailoring to students' personal preferences has drawn increasing attention in gamification, which is touted as a way forward to optimize student engagement (Luo, 2022). If feasible, the researchers may consider delivering a pre-survey to collect students' perceptions about their needs in the course. Based on students' responses, the researchers can generate a list of different tangible rewards closely related to students' needs, display them in a virtual store, assign them different values and allow students to choose which rewards to redeem.

CONCLUSION

This study applied a randomized controlled trial approach to examine the effects of tangible rewards on students' intrinsic motivation, behavioural and cognitive engagement, and learning performance in a fully online gamified flipped class. We found that tangible rewards were more effective in increasing students' task interest, encouraging them to complete class tasks and improving their final exam performance. Theoretically, the results provided support for theories perceiving tangible rewards as helpful. Practically, the results gave implications for the use of tangible rewards in gamified learning, such as linking the rewards to a standard of performance.

Several limitations of this study must be acknowledged. First, this study only examined the short-term effects of rewards on student motivation, engagement, and learning performance. It did not explore the long-term effects of rewards on student outcomes, or the potential for rewards to create an exam-oriented culture. Additionally, this study only examined the impact of rewards on a single course, which limits the generalizability of the findings. Specifically, the tangible rewards used in this study (ie, supplementary learning materials) may only be effective on students intending to prepare for the NEEP. Moreover, students with different learning abilities may perceive rewards differently. The key lies in providing rewards that align with the specific needs of the target people. One possible approach to achieve this is to utilize a pre-survey to gather information about students' individual needs prior to the commencement of the course. By adopting this approach, future studies can explore the effectiveness of tangible rewards across different courses and students, thereby enhancing the generalizability of the findings.

Second, this study focused on a fully online class using a synchronous videoconferencing tool. Hence, the findings of this study may not apply to asynchronous learning in MOOC or face-to-face teaching. It is challenging to incorporate gamification without the support of digital media in practice. Online students could check their real-time ranking in the leaderboard and receive badges immediately after completing the tasks online. However, in face-to-face classrooms, an instructor must manually keep track of every student's participation to present each student with the relevant badges. This is very difficult to do because the instructor may miss some students.

Third, due to technical limitations, students' behavioural data (eg, time spent on resources) were not recorded. Future practices could consider using such a log file to compare the differences between the patterns of use in the two conditions.

Fourth, it is important to acknowledge that the instructor's behaviour may be unintentionally influenced by the order in which the treatment was administered. To address this potential bias, future studies could employ a counterbalanced Latin Square Design for the instructor. Using this design, the instructor would teach sessions in different orders of conditions, ensuring that each condition occurs an equal number of times. The resulting design might look like this in terms of time: control 1 --> experimental 1 --> control 2 --> experimental 2, rather than two (experimental, control). Within each condition, the students would be randomly split into two sections (ie, the control condition would be two sections: control section 1 and control section 2). This approach helps minimize the impact of order effects on the instructor's teaching and allows for a more rigorous evaluation of the effectiveness of the treatment.

We propose three directions for future research. First, personalized offerings of tangible rewards could be a key consideration in sustaining student engagement in gamified learning (Tondello, 2019). Providing students with the autonomy to choose from various tangible rewards (eg, a group picture for excellent teamwork) when redeeming may be more effective than providing the same tangible rewards to everyone. Second, whether to hold a constant redemption standard or use a progressive redemption standard also deserves further exploration (Pierce et al., 2003). According to an extension of Eisenberger's (1992) learned industriousness theory, the perception of progressive efforts can lead to increasing levels of secondary reward, thereby increasing people's readiness to choose challenging tasks over less-demanding tasks. Third, future studies could employ a longitudinal study design to examine the possible enduring effects of rewards on student motivation, engagement, learning performance and exam-oriented culture.

FUNDING INFORMATION

This study was supported by a grant from the Research Grants Council of Hong Kong SAR (Project Reference No: 17616020).

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data presented in this study are available on reasonable request from the corresponding author. The data are not publicly available due to consent provided by participants on the use of confidential data.

ETHICS STATEMENT

This study was approved by the Human Research Ethics Committee of the University of Hong Kong. Informed consent was obtained from all subjects involved in the study.

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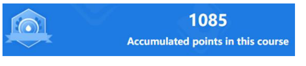
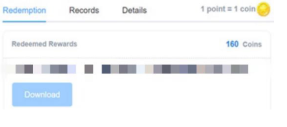
How to cite this article: Xiao, Y., & Hew, K. F. T. (2024). Intangible rewards versus tangible rewards in gamified online learning: Which promotes student intrinsic motivation, behavioural engagement, cognitive engagement and learning performance? *British Journal of Educational Technology*, *55*, 297–317. https://doi.org/10.1111/bjet.13361

APPENDIX A. OVERVIEW OF THE INSTRUCTIONAL DESIGN

Activity	Guiding the first principle	Game element	Figures
Pre-class learning materials	Activation: Necessary background knowledge was recalled	Five points for the first download of pre-class learning materials	
	Demonstration: Basic knowledge of the new learning topic was introduced	/	/
Pre-class quiz	Recalling: Students answered five multiple-choice questions by recalling factual knowledge learned from pre-class learning materials	*Task Completion* badge for completing all pre-class tasks	
		Fully Prepared badge for pre-class quiz accuracy >80%	
		Ten points for each correct answer in the pre-class quiz	/
In-class brief review	Problem-centred: Each session targeted solving real-world problems related to business	/	/

(Continues)

APPENDIX A (Continued)

Activity	Guiding the first principle	Game element	Figures
In-class lecture	Activation: The instructor briefly reviewed pre-class tasks based on the students' performance	Ten points for voluntarily answering or posing questions to the instructor in class (only the first three attempts were counted)	/
	Demonstration: The instructor illustrated the advanced learning content		/
	Application and integration: The students discussed their opinions on solving real-world problems (applying new knowledge to analyse the problems, justify their stands and propose solutions)		/
In-class quiz	Recalling: The students answered 10 multiple-choice questions by recalling factual knowledge learned from in-class learning materials	*Task Master* badge for completing the in-class quiz	
		Quiz Whiz badge for students whose accuracy rate in the in-class quiz was >80%	
		Ten points for each correct answer in the in-class quiz	
		Leaderboard with the students' overall ranking based on their accumulated points	
		(EG only) Weekly points (if at least 160 points had been accumulated) could be converted to virtual coins (1 point = 1 coin), which could be redeemed for tangible rewards	

Note: The quizzes could only be taken once. The pre-class learning materials (reading materials or videos) could be downloaded and viewed offline.

APPENDIX B. MEASURES OF STUDENT ENGAGEMENT AND INTRINSIC MOTIVATION

Student engagement (RQ)	Measurement	Data source	Analysis method
Intrinsic motivation (RQ1)	• Responses to the intrinsic motivation scale	SIMS (Guay et al., 2000)	Mann–Whitney *U* test
Behavioural engagement (RQ2)	• Completion rate of pre-class tasks, that is the proportion of students who received the *Task Completion* badge • Completion rate of in-class quizzes, for example the proportion of students who received the *Task Master* badge	System log	Chi-square test
Cognitive engagement (RQ3)	• Responses to the MSLQ	MSLQ (Pintrich et al., 1991)	Independent *t* test
Learning performance (RQ4)	• Final exam score	Final exam	ANCOVA
	• Weekly quiz scores	Pre- and in-class quizzes	Mann–Whitney *U* test