Teaching Presence in Online Gamified Education for Sustainability Learning

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Abstract: Gamification in education refers to the introduction of game elements in the design of learning processes. Our gamification approach was based on the self-determination theory. According to this theory, people need to have competence, social connectedness, and autonomy in order to feel determined to perform certain activities. We aimed to investigate the effects of teaching presence in online gamification on sustainability learning and self-determination as well as identify the driving factors and barriers to sustaining students’ participation in online gamified activity. A mobile application called JouleBug was used. It contains game elements and aims to encourage pro-environmental behaviours. Our quasi-experimental design included two university courses (as control and treatment groups) on sustainable education with 48 participants. Both groups worked with JouleBug, whereas the treatment group was also supported by their teacher’s teaching presence. To establish online teaching presence, the teacher shares the students’ leader board rankings, acknowledges the students’ achievements, and give comments and feedback on students’ activities in the chatting group twice a week. Sustainability knowledge and pro-environmental behaviour were measured through survey. Students’ performance in the gamified activities was measured through collected points in the JouleBug application. The drivers and barriers to sustaining the students’ participation in JouleBug activities were identified through focus group interviews and students’ reflection writing. We found there were significant differences in the sustainability knowledge, pro-environmental behaviour, and performance between the treatment and control groups. The Cohen’s d effect size value obtained for the treatment on sustainability knowledge, pro-environmental behaviour, and students’ performance indicates a large effect as well. Focus group interviews with the participants and the students’ reflection writings revealed that the driving factors in sustaining the participation in the gamified activities in the application are recognition by teachers and peers, competition, and sense of belonging to a group. Meanwhile, the barriers to sustaining participation in online gamification are time constraints, boredom caused by lack of social interaction, and boredom caused by activity repetition and activity’s inappropriate level of difficulty. The conclusion is the teacher plays a role as an agent in this online gamification learning context. The findings suggest that teaching presence is one of the important building blocks that encourage the students’ participation and learning in online gamification.

Keywords: gamification; environmental education; mobile apps; higher education; online learning; self-determination theory
1. Introduction

To date, human activities have been the dominant influence on the climate and the environment. In most cases, human activities create changes that are not environmentally friendly and as a result, it has led to sustainability issues, such as global warming, climate change, over-exploitation of natural resources, deforestation, and waste pollution [1]. To mitigate the consequences of human activities towards the environment, people have started developing and applying more sustainable and environmentally friendly behaviours. One of the fundamental approaches to mitigate the human-made impact towards the environment is by educating people through Education for Sustainability [1].

Education for Sustainability (EfS) has been under discussion for more than two decades since it is officially highlighted in Agenda 21 in 1992. EfS is to develop people’s awareness, knowledge, competence, attitudes, and values, which enable them to be effectively involved in sustainable development [1]. EfS requires participatory teaching and learning methods that motivate and empower learners to change their behaviour towards pro-environmental behaviour and act for sustainable development. Pro-environmental behaviour is an individual’s behaviour that contributes to environmental sustainability [2]. Higher Education Institutions (HEIs) bear a great responsibility in EfS because HEIs educate future generations that will become a professional workforce and important stakeholders in the future. Thus, it is important for HEIs to increase the students’ awareness, knowledge, skills, and values needed to create a just and environmentally friendly future. The Talloires declaration in 1990 [3] is the first statement made by university vice-chancellors on a commitment to sustainability in higher education and Agenda 21 [4] in 1992 reoriented education towards sustainable development. Since the concept of sustainability was raised in Agenda 21, the Malaysian government has promoted holistic development. Subsequently, Malaysia began to implement proactive policies and strategies from the Seventh Malaysia Plan [5] in 1996 at different levels. In 2010, the Talloires Declaration was signed by 413 universities from around the world including Malaysian HEIs.

Recent literature describes highly diverse pedagogies for EfS in school and higher education. There are a number of general principles of sustainability pedagogies including participatory and inclusive education processes, transdisciplinary, cooperation, experiential learning, and the use of environment and community as learning resources; all of which involve student-centred and interactive approaches to teaching and learning [6]. Embedding sustainability in higher education learning is promoted through various pedagogies including utilising online learning platform. Among the online learning approaches in EfS learning is online gamification. To date, the internet is revolutionising education and rapidly changing learning and teaching [7]. Furthermore, technological innovations have made online learning more easily executed.

2. Online Gamification and EfS

The online gamification approach is gaining attention from the practitioners and researchers in the EfS fields [8]. Gamification in education refers to the introduction of game design elements and gameful experiences in the design of learning processes. Gamification is widely employed in education [9]. The most used game elements in the education setting are point systems, levels, and leader boards [10]. Some researchers contended that gamification approach in learning has the potential to engage learners and encourage targeted behavioural change [11]. In teaching EfS, one of the main learning objectives is to encourage behavioural change towards more environmentally sustainable actions [12]. In line with this, Langendahl et al. [10] and Nordyby et al. [13] argued that gamification pedagogic approach can be used to improve students’ engagement in EfS. A study by Langendahl et al. [10] explores how gamification pedagogic approach can improve students’ engagement in management education for sustainable development. The study [10] found that gamification can be utilised in teaching and learning to motivate and engage students’ learning activities that involve interdisciplinary working associated with issues related to sustainable development.

Despite gaining attention and the increasing popularity of gamification in the education field, there are critiques of insufficient and inconclusive empirical evidence to support its effectiveness [14].
This is due to unrigorously designed research to study the potential of gamification in education [13]. Using quasi-experimental designs will increase the scientific robustness in research on the gamification effectiveness in education [14]. This controversy is also reflected in some empirical studies of gamification in education, which show that its effect on motivation or participation is lower than the expectations created by the hype [15,16]. The empirical research should thereby not just be fixated on the pros of gamified learning, but also be open to the cons and the conditions when gamification for learning should be avoided.

3. Self-Determination Theory and Gamification

This study was designed based on the self-determination theory [17]. According to the self-determination theory (SDT), people become self-determined when their needs for competence, connectedness, and autonomy are fulfilled. This study aimed to investigate the effects of teaching presence in online gamification on sustainable learning and self-determination as well as identify the driving factors and barriers to sustaining students’ participation in online gamified activity. In online gamification educational research, less attention is given to the impact of teaching presence on motivating the students’ participation in the learning activity.

According to the SDT, three basic needs have been identified, namely competence, autonomy, and connectedness. Competence refers to the need for humans to achieve a variety of external and internal outcomes and to feel that they are effective in carrying out their actions [17]. Autonomy is the human need for self-control [17]. Connectedness refers to people’s desire to interact meaningfully and to establish safe and satisfying relationships with others in the social environment [17]. These three basic needs are not only important for promoting optimal growth and integration of personality but are also essential for social development and well-being. Self-determination also has an impact on motivation—people feel more motivated to take actions when they feel that what they do will have an effect on the outcome. The gamification elements embedded in JouleBug are consistent with the three basic needs for self-determination mentioned in this theory.

The SDT addresses issues of extrinsic and intrinsic motivation [17]. With extrinsic motivation, people tend to do an activity because by doing so, it will yield a reward or benefit upon completion. Meanwhile, with intrinsic motivation, people will do something purely because of enjoyment or fun. Furthermore, Darner [18] posited that the SDT has the potential to foster environmental motivation in the EFS classroom.

Intrinsic motivation can be enhanced when students feel competent to do the activity. Rewards, communication, and feedback that lead to competent feelings can increase intrinsic motivation [19]. Therefore, when designing a gamified learning activity, it is important to design an optimal challenge, motivating reward, and effective feedback [20–22]. Nevertheless, competent feelings can only increase intrinsic motivation when accompanied by feelings of autonomy. Autonomy and competence can enhance intrinsic motivation if the task is intrinsically interesting to the students [17]. For a task or activity that is not interesting to a student, extrinsic motivation aspects should be noted. The SDT has described how the social environment and extrinsic motivation are able to influence students’ persistence and engagement in an activity that the students do not have interest in.

According to the SDT, people have a natural motivation to internalise and integrate their value or regulation of activities that are not of their interest but are important in the social world [17]. The internalisation process involves the absorption of values or regulations. Meanwhile, the process of integration involves the transformation of values or regulations by external contingency into internal regulations [17]. The internalisation and integration processes are proactive processes in the social context. To encourage internalisation and integration of extrinsic motivational behaviours, social connectedness plays an important role. One of the reasons people are involved in extrinsic motivational behaviours that they do not like is because they are encouraged, exemplified, or appreciated by other relevant people [20]. The other relevant people could be family members, teachers, peers, or the community. This shows that social connectedness is important to the process of internalisation. In this
study’s context, this suggests that the teacher’s and peers’ connectedness with the students is important for students’ engagement in the gamified sustainability activities.

4. Teaching Presence in Online Gamification EfS Learning Activity

A teacher plays a central role in any formal learning environment including in an online learning setting. Teaching online involves a different skill set [23]. Effective online teachers take on the role of a facilitator of learning rather than an instructor who conveys information through directed instruction. In online learning, researchers argued that a user’s personal perceptions of presence matter more than the medium capabilities [23]. The concept of teaching presence evolved from the research on social presence and teacher immediacy. Social presence is a quality of a communication medium that can affect the way people communicate. Meanwhile, the concept of immediacy is non-verbal behaviours that can reduce the distance between two or more people. The central focus of teaching presence is to increase social presence and student learning.

In relation to online gamification learning, the teacher is not physically present as the students engage with the learning activity via a mobile application platform. Therefore, in this study we propose to bridge the gap by developing a sense of teaching presence via chatting group as can be seen in the treatment group. We hypothesised that the acts of acknowledging students’ achievement, sharing students’ activity, giving feedback by the teachers, and facilitating learning via group chat will create the sense of teaching presence, which in turn fosters social presence and student learning. The concept of teaching presence is rooted from the Community of Inquiry framework [23]. Teaching presence plays an important role in online learning because it connects learners and instructors who are not physically connected [23]. Teaching presence highlights facilitators’ responsibilities for design, organisation, facilitation, and direct instruction in the online learning community so that educational purposes can be fulfilled.

Besides teaching presence as a mediator for social presence and student learning, teaching presence in the gamification approach could also bring a sense of social connectedness. Connectedness refers to the students’ feelings of belonging and acceptance between themselves and other individuals [24]. Hamari et al. [25] postulated that in technology use that involves social interaction (e.g., commenting, ‘liking’, and sharing), a user can receive recognition for his or her activities from other users. Such recognition represents the social feedback on the behaviour. In this study, we hypothesised that the more strongly a person believes others to expect and support a certain behaviour, the more positively the recognition from conducting the behaviour and thus conforming to those expectations will be perceived by the individual [26].

Human beings have a psychological need for experiencing relatedness which is belonging and being connected with others [17]. According to the SDT, when the experience of connectedness is fulfilled, intrinsic motivation towards the activities related to that context will be increased [17]. In this study, a sense of connectedness was created by organising the students in the treatment group and the teacher into the group. This group was formed around mutual goals and shared mutual norms which are important antecedents to group cohesion [27].

In addition, knowledge building can be enhanced through social interaction and discovery. Vygotsky [28] believes that learning is influenced by the social environment and emphasises the role of social interaction in learning and cognitive development. In this study, the social interactions between teacher-students and student-student were emphasised in the treatment group. Vygotsky believes that the social environment will transform the learning experience [28]. Vygotsky’s theory suggests that communities play an important role in the process of building new knowledge. Social and collaborative interactions between community members play an important role in knowledge building as they support the triggering and restructuring of ideas.

Existing research on the impact of teaching presence only emphasises its effect on learners’ perception, rather than their engagement behaviours in online learning environments. Furthermore, less attention is given to teaching presence in online gamification. Therefore, to fill this gap, the main
The aim of this study is to investigate the effects of teaching presence on online gamified sustainability education. To further elaborate the general aim, the following specific research questions are posed:

1. Are there any differences in students’ sustainability knowledge and pro-environmental behaviour between a group with a teaching presence and a group without a teaching presence?
2. Are there any differences in students’ performance in online gamification activities between a group with a teaching presence and a group without a teaching presence?
3. What are the driving factors and barriers to influencing the students’ participation in the online gamified activities using the JouleBug application?

5. Methodology

In this section, the details on the JouleBug mobile application, the research design, and data analysis procedures will be presented.

5.1. The JouleBug Mobile Application

In this study, an online gamified mobile application called JouleBug was used to encourage students to improve their sustainability habits with pro-environmental actions. JouleBug is a standalone native application. JouleBug is an environmentally-themed mobile applications designed specifically for environmental communication, education, and action. JouleBug is an application that combines mobile gaming, social media, and educational tools to achieve the objective of developing and sustaining everyday habits in environmental education. JouleBug organises sustainability tips and actions into “Pins”. When the users completed the required action such as using reusable mug, the user “buzz” that action by clicking on a little icon that represents it. These icons are called “Pins”. To earn these Pins, users have to buzz them a requisite number of times. The 90 Pins can be categorised into three categories of actions: (i) energy-saving actions, (ii) waste-avoiding actions, (iii) water-saving actions. Some of details of the Pins are shown in Table 1. In the JouleBug application, users can press the “Buzz” button in the Pin when they perform the required action, such as buzzing the button in the “Re-print” Pin for using recycled paper, the “Bottle Rocket” Pin for using a reusable water bottle, and the “Hug-a-mug” Pin for using reusable mug. Each Pin comes with visual and informative content that provides the knowledge and motivation, and users need to make small but significant changes in their daily habits. Users press the “Buzz” button in the Pin when they complete the action and they are rewarded with points. They will be awarded with badges when they collected enough required Pin. A Badge is a collection of related Actions. To earn a Badge, a user must earn multiple Pins under a theme (e.g., Transportation). When a Badge is earned, it goes into the users’ Trophy case in their Profile. Users can share their activities with photos and posts, and follow what other users are doing. The users can climb the Leader Board as they collect Badges and Trophies.

Features in the JouleBug application are classified into three main categories; (i) earn achievements, (ii) be social, and (iii) track your progress. The features in JouleBug belonging to which game element and how it is connected to the SDT are shown in Table 2.

Game elements are assumed to help students perceive the affordances of technology or apps, and indirectly make learning visible to them. In general, the term affordance can be described as a characteristic of an object that defines how a particular object can be used.

To understand how the design of gamification activities in a mobile application can support EIS learning, there is a need to understand the game elements and their affordances, as well as understand how they affect the students’ cognitive processes that influence the behavioural changes.

Drawing from the literature, game elements can be categorised into a few categories such as surface elements, underlying dynamics, and game experience [14]. The first category of game elements is surface elements. Hamari et al. [25] argued that in gamification approach, surface elements (e.g., point systems) are the most common type of game element implemented. Surface elements are usually used for the purpose of visualising individuals’ performances and achievements. The feature Earn
Achievements in the JouleBug can be classified as surface element (refer to Table 2). Moreover, surface elements such as points and leader boards are able to motivate targeted actions by providing feedback and visualising individual progress [10]. However, the effect on long-term motivation to perform targeted actions such as environmentally sustainable behaviour caused by gamification is debatable in the literature.

Table 1. Details of Pins in JouleBug application.

| Pins          | Actions                                           |
|--------------|--------------------------------------------------|
| Energy saving| Turn off computers, printers, and office lights when leaving |
|              | Install a CFL bulb                                |
|              | Skip the dryer by using clothesline to dry clothes |
|              | Lower the thermostat on the water heater          |
|              | Turn off and unplug when not using the electronic devices |
|              | Use solar-powered light for outdoor               |
|              | Upgrade to LED bulb                               |
| Water saving | Install a laundry-to-landscape greywater system   |
|              | Turn the water off while brushing teeth or shaving |
|              | Avoid flushing                                    |
|              | Skip washing car                                  |
|              | Use mulch around the base of the trees            |
|              | Create a rain garden                              |
|              | Buy a rain barrel to store rainwater for watering  |
|              | Wash a full load of clothes                       |

| Waste avoided| Refill ink cartridge                  |
|              | Use a reusable water bottle            |
|              | Use reusable mug                      |
|              | Use reusable silverware instead of plastic |
|              | Eat last night’s leftover for lunch    |
|              | Put food scraps in the compost bin     |
|              | Buy something from thrift store        |
|              | Recycle electronic devices             |
|              | Switch to online bill                 |
|              | Recycle paper, bottles, or other non-trash |
|              | Use recycled paper                    |
|              | Use reusable shopping bag              |

Table 2. Type of game elements featured in JouleBug and connection to self-determination theory.

| Game Elements                          | Features in JouleBug | What it Does?                                                                 | Self-Determination Theory |
|----------------------------------------|----------------------|-----------------------------------------------------------------------------|---------------------------|
| Surface elements (i.e., points, badges)| Earn Achievements    | Buzz feature to update every activity in the app.                           | Competence                |
|                                        |                      | Each buzz will allow users to earn a point and later badges.                |                           |
| Game experience (i.e., Enjoyment, Competition) | Be Social             | Students can share their activities in social media platforms such as Facebook and Twitter by uploading pictures. | Connectedness            |
|                                        |                      | Students can follow updates from other users’ activities and give responses (likes and comments). |                           |
|                                        |                      | Students can compete in a challenge with each other either locally or internationally in order to see who is the greenest. |                           |
| Underlying dynamic (i.e., progression) | Educational Tool     | Students can track progress by looking at the statistics of the achievement and points earned through Impact Stats. | Autonomy                  |

The second category of game elements is underlying dynamic. This game element encapsulates game-like conditions in the non-game contexts. Most games employ this element through narrative, freedom to fail, a sense of progression, and multiple pathways [10]. Freedom to fail permit users to
pursue certain actions without the fear of causing damage. Progression is another dynamic attribute used in games to inform the player about their development, for example game levels that create a sense of direction through the game. The JouleBug Educational Tool feature where students can track their progress can be classified as underlying dynamic element (refer to Table 2).

The third category of games elements is game experience. Game experience refers to the game attributes that create game-like conditions in the non-game contexts such as challenges, competition, and enjoyment. Games usually involve some form of competition that engage and motivate players to compete. Games can also provoke a sense of enjoyment to the players. The Be Social feature in JouleBug can be classified as game experience element because it involves enjoyment and competition (refer to Table 2).

In this study, learning about sustainability became visible to learners through game elements embedded in JouleBug. The elements described in the table worked as an enabler for allowing students to perceive the function of the application. As such, the affordances of the technology played an important role in providing a supportive learning environment for the students, particularly in facilitating the desired learning tasks [29]. The argument of how gamification has affected students’ cognitive processes that influence the behavioural changes in this study can be explained with the SDT. The Earn Achievements feature in JouleBug can fulfil the need for competence in the SDT. This is because when the students do the activity, they will earn points. They will be awarded with badges when they collect enough points. These features (i.e., points and badges) will enable them to gain mastery of the task. When they feel they have the skills needed for the task, they are more likely to keep participating in the task given in JouleBug. The Educational Tool feature in JouleBug can fulfil the need for autonomy in the SDT. Through the Education Tool feature, students can track their progress and they feel in control of their own behaviours and goals.

Meanwhile, the Be Social feature in JouleBug is related to the need for social connectedness in the SDT. In the Be Social feature, students can share their JouleBug activities in social media platforms. Furthermore, students can follow updates from other users and compete with other users. However, in the Be Social feature, the role of the teacher/mentor/facilitator was not included. We hypothesised that the teacher presence to facilitate learning will foster social presence and student learning. According to Vygotsky’s socio-constructivism theory, students learn more when collaborating with others who have a wider range of skills and knowledge than the students currently do, which is the teacher [28]. The teacher “scaffolding” assists the students by expanding their learning boundaries and learn more than they would be able to on their own. Therefore, to test our hypothesis in this study, online gamification is accompanied by teaching presence in the treatment group, while the control group utilised online gamification solely.

5.2. Research Design

To investigate the impact of teacher presence on online gamification EfS learning, this study utilised a quasi-experimental design. The quasi-experimental design was appropriate for this study because the aim of this study was to study the impact of an intervention on a target population without random assignment. The quasi-experimental design used non-randomised study participants. This study involved a small sample size. Students enrolled in the Environmental Responsibility course and Environmental Education and Sustainability course were selected as the participants. Twenty students in the Environmental Responsibility course were assigned as the control group, while 28 students in the Environmental Education and Sustainability course were assigned as the treatment group. For both groups, the course coordinators set the same minimum point requirement (i.e., 200 points in JouleBug) in order for them to get 10% marks for their courses. Each “Pin” has different points. For example, when the users do the activity in “bottle rocket” Pin, they earn 10 points and they earn 20 points when do the activity in “LED upgrade” Pin.

The research design for these two groups are displayed in Figures 1 and 2. Figures 1 and 2 show the research procedures in both groups.
To ensure the validity of the study, the participants in the control and treatment groups need to be homogenous. The researchers assessed this by giving pre-test for both groups. The pre-test results (in Table 4) for both groups indicated that there were no large differences in terms of their sustainability knowledge, and pro-environmental behaviour, thus both groups were homogenous. Furthermore, to ensure the validity, both groups were given the post-test concurrently.

Before the study started, the teacher briefed the student participants in both groups about the gamified sustainability mobile application. The same teacher was involved for both groups. Both groups were assigned to participate using the application as part of their assignment for the courses. Both groups were given the same weightage mark percentage for their participation in using the sustainability mobile application. Both groups were given a pre-test to set baseline data prior to using the application. In the pre-test survey, the participants’ knowledge of sustainability issues, pro-environmental behaviour, preferences in online gamification, and hours spent on social media and online applications were assessed using questionnaire.

There were different procedures applied for the treatment and control groups. In the treatment group, the teacher played an active role. As shown in Figure 1, during the students’ participation in using the application, the teacher shared the students’ leader board rankings, acknowledged the students’ achievements, and provided comments and feedback on students’ activities in the Telegram group twice a week to develop the teaching presence and create the social engagement amongst the student participants in the treatment group. The teacher acknowledged the interesting activities performed by the students in the treatment group by sharing the activity photos in the group, “like”, and “comment” on the students’ posts in the JouleBug application. Meanwhile, in the control group, the teacher did not interfere with the students’ participation in using the application.

After eight weeks of participating in the activity, the post-test was given to the students and the students in both groups were required to write their reflections of their experience concerning the
driving factor that encouraged them to participate in using the JouleBug application. The students were also required to write their reflections of the barriers to participating in using the application.

After completing the activities in the JouleBug application, six students from the treatment group and five students from the control group were interviewed. The objective of the interviews was to gain insight into the driving factor and barrier that impacted the students’ participation in the gamified activities using the JouleBug application. The focus group interviews which were carried out with six students from the treatment group took approximately 75 min. The interviews were conducted in a non-formal setting and recorded using a voice recorder. The focus group interviews were transcribed verbatim into Microsoft Word documents.

5.3. Data Analysis Procedures

The students’ reflections and focus group interview transcripts were analysed using the thematic analysis approach. By adopting the thematic analysis to analyse the data gained from the focus group interviews and students’ reflections, a four-step process was utilised to gain insight into the drivers and barriers to sustaining participation in gamified activities using the JouleBug application. The four steps were:

1. Becoming familiarised with the interview data and transcribing the data
2. Developing descriptive and interpretive codes. The codes developed were inductive and data-driven.
3. Reducing and integrating the code sheet into categories
4. Constant comparison and identifying emerging themes

The quantitative data from the pre-test and post-test were analysed using the SPSS version 25. Besides the data from the pre-test and post-test, the mean values of the cumulative points in the JouleBug application gained by the participants in the control and treatment groups were analysed. The 90 environmental sustainability actions in JouleBug were categorised into three main categories: carbon dioxide saved, waste diverted, and water saved. The cumulative mean scores between the treatment and control groups were compared.

For the main objective of this study, quantitative instruments were used to test the influence of teacher presence and social connectedness. For the secondary purpose which was to know the drivers and barriers to influencing students’ participation in the activity, qualitative approach was used (in Table 3). The reason for collecting the secondary database was to address different questions and provide support for the primary purpose.

| Research Questions                                                                 | Instruments                  | Data Analysis |
|-----------------------------------------------------------------------------------|------------------------------|---------------|
| 1. Are there any differences in students’ sustainability knowledge and pro-environmental behaviour in the control and treatment groups after the intervention? | Questionnaire                | t test        |
| 2. Are there any differences in students’ performance in online gamification activities between a group with a teacher presence and a group without a teacher presence? | Final accumulative points in JouleBug | t test        |
| 3. What are the driving factors and barriers to influencing the students’ participation in the gamified activities using the JouleBug application? | Students’ reflection Semi-structured interview | Document analysis Thematic analysis |

6. Findings

This section will present the quantitative and qualitative findings in this study. The quantitative data consisted of pre-test and post-test scores and cumulative points accumulated by the participants
in the JouleBug application activities. Meanwhile, the qualitative data in this study were from the students’ reflections and focus group interviews.

6.1. Quantitative Findings

Table 4 shows the pre-test and post-test for the domains of sustainability knowledge and pro-environmental behaviour in both groups. The questionnaire in the pre-test used a five-point Likert scale. The mean (i.e., average) values for each domain in the questionnaire for both groups were calculated.

Table 4. Independent t test of the pre-test for the treatment and control groups.

| Domain                      | Group          | Pre-Test | t     | p    |
|-----------------------------|----------------|----------|-------|------|
|                             |               | n | Mean | SD   |
| Sustainability knowledge    | Treatment     | 28 | 3.44 | 0.37 | 0.722 | 0.474 |
|                             | Control       | 20 | 3.36 | 0.39 |       |       |
| Pro-environmental behaviour | Treatment     | 28 | 3.67 | 0.36 | 0.394 | 0.695 |
|                             | Control       | 20 | 3.62 | 0.52 |       |       |

As shown in Table 4, the independent t test for the sustainability knowledge and pro-environmental behaviour pre-test of the both groups did not have significant difference, with the $p = 0.474$, and $p = 0.695$ ($p > 0.05$). Thus, the treatment and control groups were homogenous groups.

After eight weeks of the intervention, both groups were given a post-test. Table 5 displays the post-test results. The post-test mean score for the treatment group was higher than the control group’s mean score of for all the domains (i.e., sustainability knowledge, and pro-environmental behaviour).

Table 5. Independent t test and effect size value of the post-test for the treatment and control groups.

| Domain                      | Group          | Post-Test | t     | p    | d    |
|-----------------------------|----------------|-----------|-------|------|------|
|                             |               | n | Mean | SD   |
| Sustainability knowledge    | Treatment     | 28 | 4.23 | 0.28 | $-7.237$ | <0.001 | 2.017 |
|                             | Control       | 20 | 3.40 | 0.51 |       |       |       |
| Pro-environmental behaviour | Treatment     | 28 | 4.51 | 0.33 | $-8.373$ | <0.001 | 2.369 |
|                             | Control       | 20 | 3.52 | 0.49 |       |       |       |

Independent sample $t$ test for sustainability knowledge post-test between control and treatment groups showed that there were significant differences in sustainability knowledge with the value $t = -7.237$ and $p < 0.001$. Similarly, in the independent sample $t$ test for pro-environmental behaviour between treatment and control groups, there were significant differences in pro-environmental behaviour in the post-test with the value $t = -8.373$ and $p = 0.000$ ($p < 0.05$).

For the independent samples $t$ test, Cohen’s $d$ effect size was determined by calculating the mean difference between control and treatment groups in the post-test, and then dividing the result by the pooled standard deviation.

$$Cohen’s\, d = \frac{(M_2 - M_1)}{SD_{\text{pooled}}}$$ \hspace{1cm} (1)

$M_2 =$ Treatment group mean  
$M_1 =$ Control group mean  

$$SD_{\text{pooled}} = \sqrt{(SD_1^2 + SD_2^2)/2}$$ \hspace{1cm} (2)

$SD_1 =$ Control group standard deviation
SD2 = Treatment group standard deviation

The Cohen’s effect size value for sustainability knowledge was $d = 2.017$, which indicates a large effect size of the treatment for sustainability knowledge. The effect size value was $d = 2.369$, which indicates a large effect size of the treatment for pro-environmental behaviours.

After the students completed the activities in JouleBug, the students’ performance using the application was assessed through the cumulative points obtained by them. Table 6 shows the mean points for the JouleBug activities performed by the students in the control and treatment groups. The mean points of the activities in JouleBug for the treatment group were higher than the control group. Independent sample $t$ test showed that there are significant differences in the mean points of the JouleBug activities between treatment and control groups, $t = -139.407$ and $p < 0.001$ ($p < 0.05$). The effect size value was $d = 38.108$, which indicates a large effect size.

| Group         | n  | Minimum Points | Maximum Points | Mean | SD  | t      | p     | d    |
|---------------|----|----------------|----------------|------|-----|--------|-------|------|
| Treatment group | 28 | 220            | 1000           | 560  | 3.23| -139.407| <0.001| 38.108|
| Control group  | 20 | 120            | 450            | 320  | 8.30|        |       |      |

### 6.2. Qualitative Findings

The qualitative data consisted of the students’ reflections and interview transcripts from focus group interviews with the students in the treatment groups. The students’ reflection and focus group interviews with the students in the control and treatment groups were analysed to identify the drivers and barriers to performing the sustainable activities in JouleBug.

#### 6.2.1. Drivers for Performing the Sustainable Activities in JouleBug

The emerging drivers from the data analysis were: (i) recognition by the teacher and peers, (ii) competition, and (iii) sense of belonging to a group. The themes developed were data-driven or inductive.

**Recognition by the Teacher and Peers**

The students in the treatment group stated in their reflections and interviews about recognition by the teacher and peers that it was one of the factors that motivated them to engage in the JouleBug activity. Student G1 stated, “I feel appreciated by the teacher, when she (teacher) shared my activities in the Telegram group (Student G1)”. In the same vein, another student stated that recognition by the teacher led to her feeling that she wanted to also do the activity. She explained, “When the teacher shared my friends’ activity in JouleBug, it made me want to do that activity too. It’s like you want to compete with your friends” (Students A1). Another student in the treatment group also commented about recognition by the teacher and peers. She mentioned, “I felt excited when the teacher and friends liked my activities’ photos in JouleBug” (Student N1).

**Competition**

Another social connectedness influence identified in this study was competition. The competition occurred amongst the students in the treatment group. As student A1 noted, “Ranking in the leader board motivates me to compete with my friends” and student Z1 stated, “I feel that there is a strong competitive spirit amongst us as we race to raise our buzz point”. Moreover, student M1 elucidated, “Activities such as tournaments and challenging events make me feel more competitive and motivated to do activities that save the environment”.
Sense of Belonging to a Group

The social connectedness influence identified in this study was a sense of belonging to a group. When the students experience belonging to a group, the connectedness need will be fulfilled. This will result in an increased motivation for engaging in the activity. Student S1 argued that the influence of the sense of belonging to a group would motivate her to do the activities in the JouleBug app. She specified, “My relationships with my classmates become closer because we do the JouleBug activities together. “Buzzing” the activities in JouleBug is ‘contagious’ because when one of us is buzzing the activity, all of us will continue buzzing the activity too”. Another female student commented about the sense of belonging to a group. She mentioned, “We share the experience of sharing the buzz that exists in the JouleBug app”. Student Z1 and student A1 expounded, “One of my great experiences using the JouleBug app was when I was able to connect with friends virtually, we were doing different activities but with the same goal of ensuring environmental sustainability” (Student A1).

6.2.2. Barriers to Performing the Sustainable Activities in JouleBug

The emerging barriers to performing the activities in JouleBug for the students from the data analysis were (i) time constraint and (ii) boredom.

The students in both the treatment and control groups pointed out that one of the barriers to performing the sustainability action in JouleBug was time constraint. Student F2 in the control group noted, “The barrier is we don’t have enough time to upload images in JouleBug daily”. Similarly, student D2 in the control group stated, “Sometimes I’m very busy and forget to press the BUZZ button on the app”. The time constraint factor was also mentioned by the students in the treatment group. As explained by student A1 from the treatment group, “I need to allocate time to upload daily activities in the JouleBug, and sometimes I don’t have enough time to do that”.

Another barrier mentioned by the student participant is boredom. Student A2 from the control group specified that his boredom was caused by the activity repetition in the JouleBug application and difficulty level of the activity. Student A2 stated, “After repeating same activity in the JouleBug, it become bored”. Student A2 added, “I do same activity because other activities are difficult to do”. Student S2 from the control group also claimed that her boredom was caused by repetition of similar actions and a lack of social interaction when she did the activity. She stated, “After a while, it become bored, because I ‘buzz’ same action to get points.” She added, “it becomes bored when I post the action in JouleBug, but no one like or comment to the post.”

7. Discussion

This section discusses the findings in this study according to the research questions. The first research question is “Are there any differences in students’ sustainability knowledge and pro-environmental behaviour in the control and treatment groups after the intervention?”. Independent sample t test for sustainability knowledge and pro-environmental behaviour post-test between the control and treatment groups showed that there are significant differences. This indicated that online gamification approach in this study had an impact on the students’ sustainability knowledge. This finding is consistent with Su’s [29] study that demonstrated gamification environmental education application was effective to improve students’ sustainability knowledge. Nevertheless, online gamification solely is less effective to increase the students’ pro-environmental behaviour. This finding indicates that increment in sustainability knowledge does not necessarily lead to increment in pro-environmental behaviour as well. This finding corroborates with Fischer et al.’s [30] argument that more knowledge does not necessarily mean increased pro-environmental behaviour.

In the meantime, online gamification accompanied with teaching presence has a large impact on the students’ sustainability knowledge and pro-environmental behaviour. The teaching presence in the treatment group fosters social connectedness among the students. This finding is in line with
Morgantia et al.’s study [8] which suggests that for effective behaviour modification, we should leverage normative and committing power of social groups rather than focus on the individual.

The second research question focused on the students’ performance in online gamification activities. The second research question is “Are there any differences in students’ performances in online gamification activities between a group with a teacher presence and a group without a teacher presence?”. The students’ performance was measured by their accumulative points in the JouleBug. In the JouleBug application, they need to do a pro-environmental action to gain points. The findings from the quantitative data showed that the students in the treatment group obtained higher points for their activities in JouleBug compared to the control group. The treatment group, which had a teacher giving feedback and acknowledgement to the students, and communicating with students, were able to sustain their engagement and motivation for doing the activities in JouleBug throughout an eight-week period. Meanwhile, most of the students in the control group, after meeting the minimum point requirement set by the course, stopped doing the activity. Nevertheless, there were four students in the control group that did not meet the minimum point requirement. This situation was different with the students in the treatment group. The students in the treatment group sustained their engagement in doing the activities in JouleBug, even after they had met the minimum point requirement set by the course coordinator. All the students in the treatment group met the minimum point requirement. Creating a greater sense of teaching presence during online gamification through teacher giving feedback and acknowledgement to the students, and communicating with students in the treatment group encourage students’ participation in the activities. This finding suggests that the teaching presence has an impact on sustaining the students’ engagement in online gamified activity. This finding is consistent with many studies which found correlation between the teaching presence and students’ performances in online learning (e.g., [31]). Priesman [32] argued that students’ success in online learning is best supported through the execution of the essential teaching presence principles such as facilitating discourse, directing instruction, and instructional design and organisation rather than the presence of the teacher as such.

The third research question is “What are the driving factors and barriers to influencing the students’ participation in the online gamified activities using the JouleBug application?”. To provide a deeper understanding of driving factors and barriers to participation in the online gamified activities, focus group interviews with the treatment and control groups were carried out. In addition, the students were required to write their reflections after the eight-week period of doing the activities in JouleBug. From the focus group interviews and students’ reflections, this study identified recognition by the teacher and peers, competition, and a sense of belonging as the social connectedness influence that motivated the students to sustain their engagement in the gamified activities. Recognition by the teacher and peers, which seems to be one of the important elements that motivated the students, is in line with Hamari et al. [25], who argued that recognition is a form of acceptance which can increase motivation. Our finding also suggests the importance of teacher presence in gamification learning activities. This is similar to Joyner et al.’s [33] study that argued teacher presence in online learning is important. They found that courses with the presence of a teacher are effective in enhancing the student-teacher interaction and guidance [33]. This is also true in this study because the students in the treatment group felt that teacher’s frequent interaction with the students during online gamification activities creates the sense of teacher presence, which in turn fosters social presence and facilitates students’ engagement and learning. This study finding is in line with Malkin et al.’s [34] study, which found that online courses with teacher presence have a positive impact on learning. The teacher presence during online gamification will probably promote a successful learning process because it may satisfy a partial need for instant feedback that students long for in online learning. This is also related to SDT, which stated that feedback that leads to competent feelings can increase intrinsic motivation and this will probably lead to more engagement during the learning.

Besides recognition by the peers and teacher, the competition element in gamification is able to motivate the students to do the activity. Competitive gamification activities can encourage some types
of people to do more activities in order to compete with others, however, the competition element in gamification can also discourage others [35]. In this study, the students in the treatment group argued that a leader board could motivate them to compete to stay on top. Nevertheless, the same leader board was quite demotivating to some of the students in the control group, namely those at the bottom of the leader board. Most of the students in the treatment group were in higher positions than the students in the control group on the leader board. Therefore, the competition element in gamification should be designed carefully to provide optimal challenges for the students.

In this study, competition in JouleBug was also able to positively influence the feeling of relatedness. This is because the students in the treatment group argued that as everyone was involved in the competition, it drove the others to improve their ‘buzz’ activities in JouleBug.

The final social connectedness influence identified in this study was the sense of belonging to a group. When people feel they belong to a group, their need for connectedness is satisfied [16]. In this study, the students argued that by being connected to their peers and doing the activities together, it gave them a sense of belonging to a group that shared a mutual goal. The positive feelings evoked by being part of a group are deepened when people share experiences [35]. In the gamified learning context, learners who do the activity together and share experiences and goals have stronger bonds, which lead to the engagement, enjoyment, and higher motivation [35].

The sense of belonging to a group may lead to individuals being affected by the social influence from others in the group [27]. In this study, the sense of belonging to a group included the affective experience derived from gaining recognition by the teacher and peers and conforming with the group’s goal. Besides, the recognition by the group emerged from acceptance, which may have motivated the students to conform to the group’s expectations. Recognition as a form of acceptance may increase the cohesiveness of the group [25]. This is consistent with the finding in this study that identified recognition by the teacher and peers as motivating the students to engage in the gamified activity. Moreover, recognition by the group members may have strengthened the positive attitudes towards each other in the group. Members of cohesive groups, who have positive attitudes towards each other, tend to conform to group standards and produce uniform conduct with the other group members [36]. This is because when receiving positive feedback, individuals often feel obligated by the social norms to return the favour and reciprocate. Through this type of process, the shared norms of a group may be further diffused and strengthened.

On the other hand, a lack of social interaction becomes one of the barriers to the students in control group in sustaining their participation in the online gamification activity. As argued by De Freitas et al. [37] and Akcaoglu and Lee [38], online learning should leverage peer interaction to create social connectedness and social presence among learners.

The other barrier to sustaining participation in online gamification is the boredom caused by the repetition of actions and inappropriate level of difficulty. In order to optimally motivate the students to engage in the online gamification activity, the tasks not only should be designed in such a way that they just fall outside the learners’ comfort zone, but also still being perceived as attainable [39]. In other words, the tasks should be not too easy and not too difficult.

The last identified barrier to sustaining participation in online gamification is time constraint. This finding is in line with the integrative review by O’Doherty et al. [39] that found out the most cited barrier in the literature to completion of online learning activity is due to time constraint.

The limitations of the study are that the participants only involved the students in two courses related to environmental sustainability and the duration of the study was only eight weeks. Additionally, the impact on gender is not included because of an imbalance in the numbers of participants in terms of gender. The focus of this study only limits to the effects of teacher presence and social connectedness, and does not investigate the competence and autonomy needs as stated in the SDT framework. Future researches are suggested to study the students’ motivation for performing sustainable behaviours after the gamification learning activity has been completed. This is to assess the long-term effect of the gamification activity on maintaining sustainable behaviours amongst students. Furthermore,
future studies could investigate all the three needs, namely competence, autonomy, and connectedness in sustaining students’ participation in online gamification activities.

8. Conclusions

This study aims to investigate the effect of teaching presence on online gamified sustainability education. The findings show that teacher presence in online gamification such as giving feedback acknowledgement to the students and communicating with students encourage students’ participation and foster social connectedness during online gamification. The teacher plays a role as an agent in this online gamification learning context. Vygotsky’s social constructive theory on teacher’s role in scaffolding the students’ learning best explains these findings. The findings suggest that teaching presence is one of the important building blocks that encourage the development of social connectedness and cognitive presence to support online learning engagement.

This study finds that the link to SDT is teaching presence established by the teacher can fulfil the students’ needs for connectedness. When connectedness need, along with competence and autonomy needs are fulfilled, they will be self-determined to engage in the gamified activities. It is important for EES to not just engage the students cognitively, but also able to encourage behaviour modification towards being more environmentally friendly.

Social connectedness in terms of recognition by the teacher and peers, competition, and a sense of belonging to a group have an important effect on sustaining the students’ motivation in gamified learning activities. Meanwhile, the barriers to sustaining participation in online gamification are time constraint, boredom caused by lack of social interaction, and boredom caused by activity repetition and inappropriate activity’s level of difficulty. These findings have practical implications for designing meaningful online gamification for EES. To engage online learners, close attention needs to be given to the design of the gamified activities and allow a reasonable virtual presence of teachers/instructors/facilitators who deliver, organise, and monitor online learning. Significant teaching presence will foster learning and encourage students to engage in socialisation between students and teacher, and between themselves as well.

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