Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

Article

Edcraft: Gamified Handicrafts as an Inspiration for Teenagers to Practice Upcycling

Xin Yee Tan, Kin Meng Cheng, Chin wei Chong * and Ah-Choo koo

Multimedia University; 1191402526@student.mmu.edu.my (X.Y.T.); tidusnjay@gmail.com (K.M.C.) and ackoo@mmu.edu.my (A-C.k.)
* Correspondence: cwchong@mmu.edu.my

Abstract: Edcraft, a recycling and upcycling event for Malaysian secondary school students, particularly in the Klang Valley area in 2020. The event's goal was to look into gamified solutions to encourage recycling and upcycling among the students' age group. Lectures, talks, practical exercises and games were used to teach students about climate change and environmental preservation. According to a post-event survey, the percentage of participants who recycle has climbed significantly: 76% now recycle, compared to only 24% previously. The study discovered that gamification-based activities could effectively facilitate recycling and upcycling behaviours. Such solutions can be applied to encourage behavioural changes in different contexts. By interviewing 15 Edcraft students in a focus group study setting, researchers could better understand the motivations. Themes such as 'social connections are vital', 'convenience and rewards are significant motivators', 'gamified activities help attract and engage teens' and 'environmental knowledge is crucial to prolonging recycling' emerged from the thematic analysis. This manuscript proposes gamified activities to induce a behavioural change in upcycling, and the findings yield helpful insights to fuel pro-environmental behaviours.

Keywords: pro-environmental behaviours; recycling; teenagers' engagement; gamified learning activities

1. Introduction

Scientists warned about the skyrocketing carbon emissions as early as the late 19th century, suggesting that they could contribute to global warming. Thus pro-environmental behaviour (PEB) should become a necessity for human survival (Benyamin et al., 2018). However, the warning has not always been taken seriously enough due to the acts of deniers and sceptics as well as economically oriented policies (Eisenack & Reckien, 2013). Effective climate change policy relies on the public's support and understanding; those aware of or experiencing climate change are key supporters of climate policy (Rhodes et al., 2017). As climate change is a global issue felt on a local scale, it cannot be tackled solely via individual effort; it is necessary to expand public awareness and empower people to address it (Eisenack & Reckien, 2013). However, improving environmental awareness is only the first step. Governments, communication and education experts, and environmental activists recommend going beyond boosting awareness and understanding to encourage people in modifying their behaviours to reduce the planet's stress.

In pursuit of innovative and interactive ways to educate and engage citizens, especially young people, gamification has gained the attention of scholars and practitioners in recent years. Gamification, which is the application of game-design features in non-game contexts, is seen as a strategy for positively engaging people in behavioural change (Hamari et al., 2014; Mazur-Stommen & Farley, 2016).

The use of gamification to instil recycling behaviour for waste reduction is still in its infancy, and its' potential has been understudied (Morganti et al., 2017). Through Edcraft, a programme that instils recycling and upcycling behaviour through gamified activities,

© 2022 by the author(s). Distributed under a Creative Commons CC BY license.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

the impact of gamification in affecting recycling behavioural change is explored in this research. School-aged children who participated in the programme are later interviewed about their perceptions and experiences about Edcraft, recycling, and upcycling.

2. Literature Review

In recent years, we have seen a transition in climate and environmental education from exposure to information to transformation of values and behaviours to contribute to solutions for environmental problems and, by extension, establish a sustainable society. Individuals are encouraged to engage in pro-environmental behaviours via stimulating their interests and increasing their understanding and participation.

Recycling, a form of pro-environmental behaviour that aids in trash reduction, has been widely implemented since 1993 (Mahmud & Osman, 2010). However, it is not commonly practised in Malaysian households, where the national recycling rate stands at 31.52% in 2021. Due to recycling practices having yet to become a norm in Malaysia, the country loses an estimated RM476 million in recyclable resources yearly. Most Malaysians are unaware of the high commodity value of the rubbish they generate, and their ignorance is reflected in the recycling rate. Although the recycling rate has been improving yearly, from 5% in 2006 to the current figure, it is still relatively low compared to other developing countries where recycling rates exceed 60%.

More active citizen participation, which might be strengthened by providing advantages to active citizens, is one of the strategies to help increase the recycling rate. Gamification is a concept that allows the recycling process to be motivated and carried out more dynamically to accomplish desired objectives. This study aims to investigate and close the gap between gamified learning and recycling among teenagers.

Governments and environmental organisations have been battling for environmental conservation, primarily through educating people about waste reduction and promoting recycling. However, these large-scale projects will only be feasible if the next generation adopts an eco-conscious lifestyle. The three pillars of waste reduction are reduce, reuse, and recycle, and developing these values from an early age should be a primary focus. Environmental education encourages recycling awareness within societies (Mahmud & Osman, 2010). However, although it has been integrated into the Malaysian school system, the students are not committed to translating such knowledge into actual behaviours.

If beneficial ecological policies are not enacted swiftly, individuals, society, and the planet will suffer from the consequences. Unfortunately, current guidelines do not guarantee a more environmentally-friendly future, owing to the fact that improvements can take years and not all nations contribute equally. Meanwhile, experts forecast that the impacts of climate change will continue to worsen, affecting all organisms on the globe, necessitating an urgent increase in environmental and climatic action. As recycling comes with a learning curve, if we want environmental initiatives to thrive, we must instil a green mindset in today's youth where they make conscious decisions to reduce waste.

Deterding et al. defined gamification in 2011 as "the use of game design principles in non-game contexts," whereas Mazur-Stommen and Farley (2016) broadened the scope to include behavioural change. Gamification, they explained, is the process of incorporating game mechanics into regular tasks to increase motivation for behavioural change. Gamification is considered as "approaching problems to tap into the psychology of motivation" from this standpoint.

Motivations that lead to behavioural change can be classified into extrinsic and intrinsic factors. Extrinsic motivation is based on external stimulation to change behaviour, while intrinsic motivation is self-driven. According to Grossberg et al. (2015), the points, badges and leaderboards system provides players with obvious and fast incentives and is a potent motivator to improve players' behaviours. When players compare their performance records to their peers, they will feel more accomplished and are more likely to maintain or enhance their present behaviours.

Despite the fact that gamification has been utilised in social settings, it has only been employed in environmental sustainability studies to improve attention, intention, and

behaviour to a limited extent (Maltseva et al., 2019). Hence, its potential in aiding pro-environmental behavioural change needs to be explored.

This research used a gamified learning activity called Edcraft to motivate teenagers to recycle. Teenagers' opinions and attitudes about the value of PEBs, such as recycling activities, were gathered using qualitative research approaches. In this study, two research questions were sought to be answered: (1) How does gamified learning encourage teens to participate in recycling activities? (2) What factors influence teenagers' recycling behaviours?

As global climate change accelerates, the younger generations will be the first to suffer the impact. Hence, Fernandez and team (2014) asserted that increasing climate change awareness among today's youth is crucial since they are most affected by disasters, and their well-being may be jeopardised. In addition, they could provide energy, innovative thinking, and commitment to drive innovation and transformation, thus, necessitating additional work to engage them in environmental action effectively (Quiroz-Martinez et al., 2005). In 2020, UNICEF released a statement that 9 in 10 youth in Malaysia have experienced environmental and climate-related effects in the last three years. 92% of young people believe that climate change is a crisis. The youth are aware of the environmental issue, and awareness alone will not transform the situation. Action, on the other hand, requires the cultivation of behaviour.

"Youth" refers to teenagers and young adults (ages 15 to 24). Teenagers, also known as adolescents, are people aged 13 to 19, with ages varying by country: United States (15-17), Singapore (13-19), and Malaysia (13-15) (Reynolds-Tylus et al., 2021). Teenagers account for 17% of the world's population, or 1.2 billion people, with the majority (87%) living in developing countries. As the next generation of individuals and national leaders, they will be able to bring fresh ideas to the table in the future. As a result, it's vital to educate people about the consequences of unethical rubbish disposal and the management of climate change (Narksompong & Limjirakan, 2015).

These young people, particularly teens, spend a significant amount of time playing games regularly. Hence, an empirical study in the context of gamification concentrating on gamified environmental sustainability is required. Furthermore, gamification holds great promise in environmental education, as collaborative and engaging mechanics are needed to promote PEB (Portela, 2020). Thus, this qualitative study was conducted to provide insights into the attitudes of teenagers regarding recycling activities in a gamification-enabled environment.

Empowering future citizens and decision-makers to reduce the effects of climate change should be a top educational priority, as they will be the ones who will have to live with the consequences of climate change and implement solutions (Narksompong & Limjikaran, 2015). According to past surveys, Malaysians' environmental knowledge, care, and awareness are low (Haron et al., 2005). Teens from secondary school ages 13 to 17 participated in this study to better understand teenagers' participation in PEB-related gamified recycling activities.

3. Research Framework

Behavioural Reasoning theory (BRT) has sparked interest among researchers in waste management recycling attitudes and intentions (Dhir et al., 2021). BRT studies consumer behaviour extensively and is applied to research on how consumers efficiently dispose of or manage their used items. BRT also considers the motivations for and against behaviours, such as recycling intentions (Karapanos et al., 2017).

Using the BRT, the "reason for" can influence the teenagers' positive intention toward environmental activity, whereas the "reason against" can affect the teenagers' negative intention (Dhir et al., 2021). According to Vanegas-Rico et al. (2018), intervention encourages positive PEB in individuals. In this study, BRT was adapted with the focus group discussion (FGD) approach to study the intention and behaviour of recycling linked to teenagers' reasons, motives, and beliefs in a gamified experience (Westaby, 2005). Unlike BRT, which explores the behavioural as the end-stage, this study only adapted to the intention stage.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

Since the 1940s, sociologists and psychologists have employed FGDs in social science research. Through focus group study, participants' PEB will be explored through the sequence of beliefs and reasons. Finally, global motives, framed within the gamified learning context as indicated in the conceptual framework in Figure 1, will be validated by analysing the data collected. These three BRT components could potentially translate into teenagers' PEB:

Belief – is the value that exists within one and is expected to impact the reasons one performs specific actions (Wang et al., 2021). It also relates to one's attitude of reacting to a fact or behaviour as truth with a sense of justice toward them (Schwitzgebel, 2019). In this study, the acceptability of recycling from gamified learning was investigated. With a high degree of acceptance, individuals understand why they should recycle.

Reason – acts as the goal of achieving an aim or the motivation to perform an action. It is likely to positively engage global motives, enhancing motivation (Westaby, 2005). A good reason will positively engage the action and drive one's thoughts for a particular behaviour. The gamified-learning scenario and recycling comprehension provide participants with a compelling rationale to move on global motives.

Global Motives – refers to the motivation to work toward recycling originating from socially perceived behaviour. In BRT, global motives are like the determinant compared to attitude, social norm, and perceived behaviour, which also determines the purpose of action (Wang et al., 2021). Furthermore, intentions are strongly associated with global motives in influencing involvement among young students (Tani et al., 2021).

The conceptual framework of gamified learning with the BRT as a guideline that leads to PEB is shown in Figure 1.

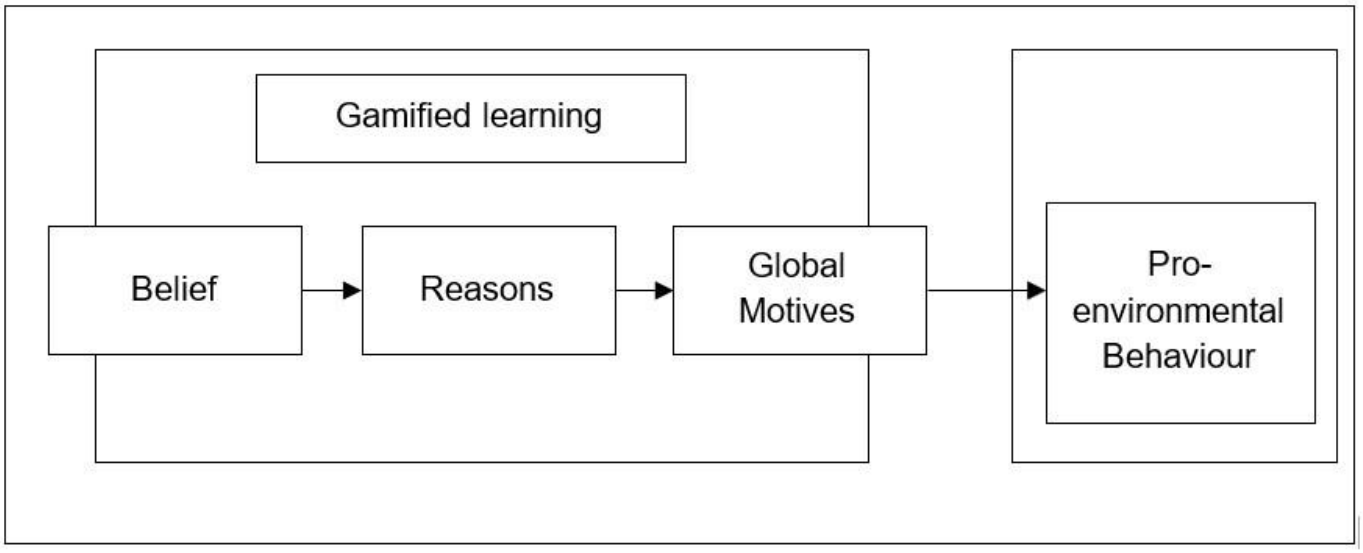

Figure 1. Conceptual framework of teens PEB based on Behavioural Reasoning Theory (BRT).

4. Methodology

This study applied Focus Group Discussion (FGD) as the primary qualitative data collection and analysis methodology to discover and further explore the emotional experience and value that lead to teenager's pro-environmental behaviour as they participate the gamified activity. First, participants were purposively chosen from the online gamified learning activity, namely Edcraft. Then, participants' responses were categorised into 38 codes for the interrater reliability agreement test before the thematic analysis.

4.1. Participants

Students from one secondary school in Klang Valley, Malaysia, were chosen after playing with an online gamified recycle crafting activity during the COVID-19 pandemic

in November 2020, namely Edcraft. Edcraft enables teenagers to experience crafting with plastic bottles that can be recycled and guided with a tutorial. They have been ranked and put on the leaderboard for gamified purposes through this activity. To achieve the research objectives, purposive sampling was applied to select participants related to the study's goal (Saunders, 2015) based on their prior experience of PEB (e.g., recycling and environmentally friendly activity, and their proficiency in the knowledge of the issue of recycling). Among the participants, fifteen teenagers between the ages of 13 and 17 who have little or no experience in recycling were invited to share their thoughts and experiences in a focus group setting.

4.2. Data collection

This study aimed to explore teenagers' PEB through beliefs, reasons, and global motives via FGD after interacting with a gamified recycling activity, namely Edcraft. In the Edcraft activity, participants from one secondary school were asked to complete a one-day handicraft activity. Following that, participants were instructed to view video instructions on the recycling craft to understand how to do the recycling craft. They were allowed one day to work freely and creatively on each craft. Art teachers will then review their work and place it on a leaderboard. Certificates and prizes will be awarded to competitors who earned a spot on the leaderboard.

On the next day of the activity, 15 participants were invited and divided into two groups, 1 group with (8) participants and another with (7) participants. One session of FGD per group with the same question asked. Study shows that social research methodology such as FGD is rooted in social interaction. That is why the theme served as a good foundation for the research aim, and together with their peers in answering the moderator's questions, it also shows their teamwork and better session throughout the discussion.

4.3. Data Analysis

This study followed the thematic analysis adapted from Krueger & Casey (2015) and Liamputtong (2011). It has been widely used as a credible and practical way for a more accurate qualitative analysis (Braun & Clarke, 2021). The process starts with the transcription to identify the patterns of recurring data that matches with the research aim to investigate the between gamified learning and pro-environmental behaviour among teenagers. Next, codes were generated and discussed. Interrater reliability was assessed before thematic analysis. Following that, themes were formed and established through a review of the discussions to answer the research questions. The study was completed by establishing a four-step trustworthiness.

5. Findings

This section will discuss the reliability assessment by the interrater regarding the codes from the FGDs and also the thematic analysis whereby the discussions were further analysed into four themes: "social connections are vital", "convenience and rewards are significant motivators", "gamified activities help attract and engage teens" and "environmental knowledge is crucial to prolonging recycling".

Interrater reliability assessment – was used to control the random agreement factor, and the kappa statistic was used to measure the confidence in correctness (Cohen, 1960). The assessment is essential to ensure trustworthiness with the involvement of the two raters. The kappa coefficient assessment was 0.77, indicating that the two raters agreed on most generated codes. Table 1 shows the crosstabulation of agreement from the 38 codes; only one code both raters have a different agreement and two codes with the disagreement, "No". Both agree with 35 other codes that the researcher has coded.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

Table 1. Crosstabulation of Rater 1 and 2.

Rater 1 * Rater 2 Crosstabulation				
Count				
		Rater 2		Total
		No	Yes	
Rater 1	No	2	0	2
	Yes	1	35	36
Total		3	35	38

Kappa (κ) coefficient assessment was carried out and presented in Table 2. The kappa statistics of agreement and symmetric measures for 37 codes was 0.770, which is a substantial strength of agreement. A substantial/excellent strength of agreement from the kappa statistic value is correlated to higher reliability for the data to be assessed by thematic analysis.

Table 2. Kappa statistics of agreement.

Symmetric Measures				
	Value	**Asymptotic Standard Errors**	**Approximate Tb**	Approximate Significance
Measure of Agreement Kappa	0.770	0.206	4.895	0.000
N of Valid Cases	37			

5.1. Thematic Analysis

Findings from interrater reliability verified the codes and proceeded with the thematic analysis. The transcripts revealed four themes: 'social connections are vital', 'convenience and rewards are significant motivators', 'gamified activities are effective in attracting and engaging teenagers', and 'environmental knowledge is crucial to prolong recycling. The number of units relating to each category is presented in brackets after the categories of each theme.

Social interactions are vital.

The teens cited social influence as a significant motivator for participating in environmentally friendly activities such as recycling (12). Others' criticism of their PEB, on the other hand, is unimportant to them (9).

Participant C mentioned, 'When I recycle, I do not care about others' opinions because it is for a good cause, like saving the Earth, so I do not care if people say that I am gathering trash.'

Some participants attempted to work together (4) to complete schoolwork or a chore task. It gave them a strong sense of belonging, which sparked their social interactions. They needed to form strong links to develop a robust pro-environmental attitude.

Participant M mentioned that 'I will say social is an important factor. For example, one of my friends is used to recycling as she was taught about it from a young age, and they practice that at home. So we need this kind of social influence more in our society, where parents spread awareness to children and friends spread among themselves.'

Moreover, Participant O said, 'Teenagers are always trying to spend time together. We like doing things together. So if we are doing something, we are most likely to call our friends to join; when we see our friends doing something, we most probably will join too. So I will say peer influence is significant.'

Discussions above show the impact of social influence among teenagers. The gamified learning activity shows its strong sense of influence in teamwork to solve a problem, task or assignment. Influence describes activities affecting social change in youth, specifically teenagers, while activities that youth participates indirectly affect social change that could lead to their motivation to participate in any PEB (Clarke & Dougherty, 2010; Lenzi et al., 2012).

Convenience and rewards are significant motivators.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

With the present population growth, several locations in Malaysia are evolving into densely populated areas. However, the recycling industry is not developing at the same rate, and some participants complained that recycling facilities were not accessible in their neighbourhood, causing them to stop recycling. Accessibility (7) and rewards (9) were essential considerations in encouraging individuals to recycle. This finding is consistent with a previous study where 'no time' and 'inconvenient facilities' were among the top reasons individuals do not recycle (Strydom, 2018).

Participant A mentioned, 'I live in a condominium, and there are recycle bins downstairs, so it is not any harder to recycle. You have to be mindful when you sort your trash at home and take them out. There is no reason not to do it when it is already convenient.'

Another participant said, 'Some people may find it hard to recycle when there is no recycling centre or bins near their house. It takes effort to gather and separate the items, and it is too far to deliver them. As a result, people might dispose of them as common waste. So I think that is a problem that needs to be solved'. Difficulty in recycling has been a reason for the participants not to recycle (6). Individuals might want to recycle first, but they lose interest due to the effort and time required.

However, Participant H stated that they might go over the convenience to recycle when a monetary reward is presented (7). 'I think money is an important reason people do recycling. For example, I send recyclables to a recycling centre, and I get money. It took my effort and rewarded me with money. That is what I think motivates most people to recycle.'

The teens have extrinsic and intrinsic reasons for the convenience and monetary reward of recycling and believing in the environment's cleanliness. Still, they lose their hope to be pro-environment when so much effort and time are taken. Intrinsically, they felt appreciated and self-gratified for the items created and extrinsically, when others impose punishment due to their mistakes or reward them well.

Gamified activities are effective in attracting and engaging teens.

Participants discussed the impact of gamified activities on encouraging teen engagement in recycling activities, claiming that such games draw teens to notice and learn about recycling (11). In addition, game elements and competitiveness satisfied teens and kept them interested (10). This theme addressed the research question of how gamified learning engages teenagers in recycling activities. Teens enjoy video games, and when video game features are incorporated into a recycling activity, it provides them with a sense of fulfilment and readiness to take positive action towards the activity, resulting in participation. Motivation draws the teenagers' engagement with an entertainment-based environment (Jin, 2014). This suggestion is supported when teenagers are satisfied with their work done and with this feeling of gratitude for crafting used items.

Participant C mentioned, 'I had great fun in the activity, it was engaging with all the game design, and I felt satisfied when I could complete my craft. Putting effort into the crafting part makes me think deeper, like I made the pencil holder from recyclables with my hands, and it made me realise how easy it is to reduce waste with simple and fun activities.'. The gamified activity encourages teens to spend their time and energy when the reason is solid and sound. They understand their expected satisfaction when they complete the craft, leading to increased global motives and eventually pro-environmental behaviour.

Participant A said, 'Having an activity like this has made me more aware of recycling. For example, when I see a plastic bottle, I will think about turning it into something useful like a piggy bank or pencil holder, instead of throwing it as I did back then.' Participants showed that their participation in this activity motivated them to recycle and the usefulness of applying the knowledge to later recycling action. The teens put effort and strength to complete the task given and are proud of their accomplishments.

Environmental knowledge is crucial to prolonging recycling.

The last theme emphasised the necessity of environmental awareness and knowledge in maintaining environmentally friendly habits like recycling. Participants discussed the current recycling situation among teenagers, concluding that ecological awareness is poor

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

among teenagers (5), with residents discarding recyclable goods as rubbish. It was suggested that campaigns educate the public on environmental conservation (9) and create environmental awareness, leading to green behaviours like recycling (7).

Participant D stated, 'I think people generally do not think about the consequences of throwing away stuff like I often see people just throw whatever they think is not useful without guilt.'

Participant D added, 'We, young people, think about the consequences of our actions. For example, people back then will throw their garbage without thinking about where it ends up, but now we are aware that trashes end up in landfills, which will cause problems to the earth. Moreover, we will think about the tangible effects of recycling, like saving paper and plastics, which are not infinite resources. So recycling is a win-win situation in that we do not waste resources and fill up the landfills as fast. First, however, this idea needs to be spread among the society, so more people will know about this and take action.'

Participant O again mentioned, 'Although game elements can motivate people to start recycling, I suppose they need something from inside to make it a habit. They need to understand what the cause is recycling for, think about the consequences of not recycling, and encourage people to make it a habit.'

Knowledge is a driving force behind PEB and a roadblock to boosting recycling rates. It is said to work hand in hand with awareness in generating positive motivation and attitude toward recycling (Afroz et al., 2017). According to the feedback, recycling intentions are likely to be achieved if individuals understand the consequences of poor waste management and have a good habit and positive attitude toward recycling.

6. Discussions

This section will discuss the findings and how each theme benefited the framework leading to the PEB from the gamified learning activity and validate the conceptual framework. The following section discusses the four steps of trustworthiness of the results to improve the findings through Credibility, Transferability, Dependability and Confirmability.

6.1. Conceptual Framework Validation

The four identified themes were to answer RQ1 and RQ2. The first three themes, 'social connections are vital', 'convenience and rewards are significant motivators' and 'gamified activities are effective in attracting and engaging teens' are addressing RQ1 in engaging teenagers to participate in recycling activities related to the Gamified learning section from the teenage gamified learning framework based on BRT's beliefs, reasoning, global motives, as shown in Figure 2. Initially, the first theme, 'social connections are vital,' has been termed social influence as the first factor for RQ2 in the teenager gamified recycling framework. The participants viewed it positively as a belief in their ability to accept themselves in a community or society where their friends and relatives serve as role models for performing a specific action, such as recycling.

Then, the second theme on 'convenience and rewards are significant motivators' has been termed 'convenience and reward', the second factor for RQ2. It was the reason for the teenagers to join the recycling activity. It was also part of their motivation from the satisfaction of completing the activity and knowing the reward that they may get, competition pressure from peers in gamified learning where game elements that motivate (i.e., leaderboards, points and ranking) are crucial.

The third theme, 'gamified activities help attract and engage teenagers', incorporates the two themes, 'social influence' and 'convenience and reward'. That leads to the term 'participation in the gamified recycling activity. The participation does not come in enforcement but through the motivation boost from peers and rewards from themes 1 and 2.

The fourth theme, 'environmental knowledge is crucial to prolonging recycling', is termed 'pro-environmental behaviour' as a factor for RQ 2. The previous three themes,

categorised as 'social influence', 'convenience and reward' and 'participation', as shown in Figure 2, are the factors that influence teenagers' recycling behaviours that address RQ2. By interpreting and understanding the themes, a rich environmental knowledge learned from a gamified learning environment revolves around social influence, convenience and reward, and participation drives PEB.

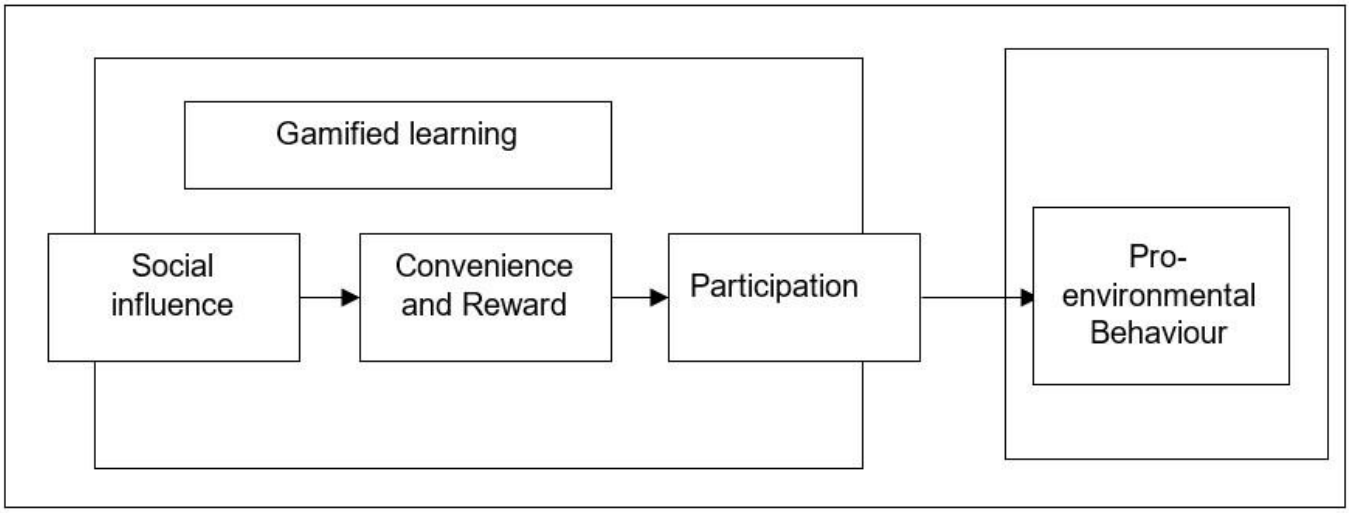

Figure 2. Validated gamified recycling framework for teenager.

6.2. Trustworthiness of the findings

The lack of quantitative figures in the thematic analysis could raise a concern about the consistency of the analysis. To ensure that the findings are reliable and persuade readers of the qualitative themes, stringent criteria were on the four steps of trustworthiness (Guba & Lincoln, 1985). This section comes in where the procedure ensures the qualitative results were further enhanced.

Credibility – To establish confidence, each FGD session was kept with minimal participants to ensure each Participant had a chance to speak and the most relevant data could be retrieved. Also, pilot interviews have been conducted to rehearse with colleagues beforehand to identify the weaknesses during the FGD moderation process.

Transferability – Focus group discussions aim to gather information from a specific group of people. In this study, purposeful sampling was used to maximise detailed data concerning the context in which it was obtained, distinct from the aggregate data that would result from the quantitative study. Purposive sampling considers the features of the sample individuals. They needed to be between the ages of 12 and 17, with little knowledge about pro-environmental behaviour or recycling and little experience in video games, which is directly relevant to the study topics.

Dependability – The authors have reviewed the work to ensure that the research methodology was "logical, traceable, and recorded" (Tobin & Begley, 2004). Audited by more readers gives more dependability to make the study more transparent and understandable.

Confirmability – Credibility, Transferability and Dependability mentioned above have been conducted and attained. Researchers discussed the study to ensure that the data collected was relevant to the two research questions and confirm the conceptual framework with themes, as shown in Figure 2. Three factors, social influence, convenience and reward, and participation, have been identified from the conceptual framework. Confirmability also ensures that the Behavioural Reasoning Theory, teenagers, gamified learning and recycling references, and thematic analysis procedures fit together correctly and minimise the risk of error.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

6.3. Implications for future study

The findings of this study helped determine the present state of recycling among Malaysian teenagers and the common elements that impact or inspire high school students to participate in recycling activities. Understanding how to encourage PEB in teenagers will be critical in addressing today's ecological concerns, mainly because these young people will be the environmental movement's future leaders.

Compiling the insights gained from the FGDs, recycling activities appear favourable and accessible to Malaysian teens, but that is only temporary. Participants agreed that they are necessary and capable of addressing the climate challenge. However, they lack the knowledge to deal with the looming crisis, as many teenagers are unaware of the environmental concern due to a lack of environmental education. Time and opportunity are usually the obstacles. However, social and rewards are the most common motivators for teens to engage in PEB. Teens may consider material benefits as their most significant benefit, but they are not taught about the long-term calamity created by garbage.

There was little previous research in this field, and the data were analysed using the thematic analysis technique. The strategy was very helpful in obtaining the exploratory data described in this paper about earlier discoveries. Our findings showed that recycling habits among Malaysian teenagers need to be addressed and that gamified activities have a great potential in environmental education. These findings could be helpful for Malaysians, especially the younger generation, to learn about gamified learning on pro-environmental behaviour that could manifest daily recycling habits through the gamified learning environment.

6.4. Limitations & Future Directions

Insights from this study can help educators and policymakers select best practices in promoting similar pro-environmental behaviours. Even if gamification seems like a promising and effective intervention to foster pro-environmental behaviours, this study still has some critical limitations.

Possible long-term effects represent the first one. Short-term improvements in participants' recycling behaviour were reported; however, the long-term effects were not observed. As most behavioural changes do, pro-environmental behaviours require an extended period of practice before becoming a habit. In most cases, the lack of evaluation of long-term effects makes it difficult to understand if people maintain the acquired behaviours over time. Previous studies reported conflicting results when the interventions' short- and long-term effects were compared (Kjeldskov et al., 2012; Knol & De Vries, 2011). These authors reported significant short-term improvements but no significant changes over more extended observation periods. Hence, it is necessary to observe the long-term effects with the same methodology to evaluate the effectiveness of the interventions.

Also, the data were only collected from one secondary school in Malaysia. Therefore the sample could not be considered a genuinely representative sample in a bigger picture in the Malaysian context. Future studies should recruit a larger sample of students from various Malaysian cities to improve the representativeness of the survey and generalizability of the finding. Moreover, university students should also be included in future studies as they are also the younger generation who must face the negative impact of global climate change. Including their opinions could provide a comprehensive picture of the socio-psychological factors that influence the recycling intentions of young adults.

Apart from recycling intentions, prior recycling behaviours should also be studied to observe gaps between pro-environmental intentions and PEBs. Furthermore, future studies could also investigate how economic rewards could influence recycling behaviours among the young generation. As monetary incentives were a significant motivating factor in this study, the lack of financial incentives was cited as one of the main factors that affected individuals' recycling intentions (Halder & Singh, 2018).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

As it is an emerging field of research, relatively few studies in the literature explore how gamification can impact upcycling behaviours. However, gamification still seems a promising way to promote upcycling behaviours. It can create a reward/penalty system that provides the chance to communicate which behaviours are desirable and which ones are not, where individuals would collect rewards for personal satisfaction and game dynamics. With a set of goals established, individuals would display short-term improvements in upcycling behaviours and aim at long-term results simultaneously. Gamification also helps stimulate social comparisons, creating challenges with other players by showing feedback comparisons.

7. Conclusions

In the recent decade, the growth of interest in recycling has been observed, and the current research adds to the broader literature on recycling and upcycling among teenagers. The findings above indicated some critical conclusions on how teenagers perceive climate change regarding its consequences and the actions taken to mitigate it. Climate change knowledge is solid among today's teen population, as it is widely taught in schools. However, this awareness does not always transfer into pro-environmental intentions or actions. To learn more about the awareness-intention gap, researchers should look at the factors influencing teen recycling habits. Similar studies should be conducted in the future, not only in recycling activities and among teenagers but also in other contexts such as sports volunteering and disaster relief. Validating the identified elements in the field study, such as sending out a questionnaire to explore the problems experienced by high school students in engaging in recycling activities, could also help further the investigation.

References

Afroz, R., Rahman, A., Masud, M. M., & Akhtar, R. (2017). The knowledge, awareness, attitude and motivational analysis of plastic waste and household perspective in Malaysia. Environmental Science and Pollution Research, 24(3), 2304-2315. https://doi.org/10.1007/s11356-016-7942-0

BBC. (2021, July 28). Greta Thunberg: Who is the climate campaigner and what are her aims? BBC News. https://www.bbc.com/news/world-europe-49918719

Benyamin, A., Djuwita, R., & Ariyanto, A. A. (2018). Norm activation theory in the plastic age: Explaining children's pro-environmental behaviour. E3S Web of Conferences, 74, 08008. https://doi.org/10.1051/e3sconf/20187408008

Braun, V., & Clarke, V. (2021). To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. Qualitative Research in Sport, Exercise and Health, 13(2), 201-216. https://www.tandfonline.com/doi/citedby/10.1080/2159676X.2019.1704846?scroll=top&needAccess=true

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. SSRN Electronic Journal, 395(10227), 912-920. https://doi.org/10.1016/S0140-6736(20)30460-8

Cheng, K. M., Koo, A. C., & Nasir, J. S. (2020). Educational Crafting (Edcraft): A gamified Classroom for Recycling Intention. Journal of e-Learning and Higher Education, 2020. https://ibimapublishing.com/articles/JELHE/2020/346020/

Clarke, A., & Dougherty, I. (2010). Youth-led social entrepreneurship: Enabling social change. International Review of Entrepreneurship, 8(2), 1–23.

Cohen, J. (1960). A coefficient of agreement for nominal scales. Educational and Psychological Measurement, 20(1), 37-46. https://doi.org/10.1177/001316446002000104

Correa, C., & Kitano, C. (2015). Gamification in Tourism: Analysis of Brazil Quest Game. e-Review of Tourism Research, 6, 1-5. https://www.researchgate.net/publication/286926048_Gamification_in_Tourism_Analysis_of_Brazil_Quest_Game

Das, S., & Bhattacharyya, B. K. (2014). Estimation of municipal solid waste generation and future trends in greater metropolitan regions of Kolkata, India. Journal of Industrial Engineering and Management Innovation, 1(1), 31. https://doi.org/10.2991/jiemi.2014.1.1.3

Department of Statistics Malaysia. (2020). Press release: Compendium of Environment Statistics, Malaysia 2020. https://www.dosm.gov.my/v1/index.php?r=column/pdfPrev&id=TjM1ZlFxb3VOakdmMnozVms5dUlKZz09

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to Gamefulness: Defining "gamification". In Proceedings of the 15th International Academic MindTrek Conference: Envisioning future media environments. Association for Computing Machinery.

Dhir, A., Koshta, N., Goyal, R. K., Sakashita, M., & Almotairi, M. (2021). Behavioural reasoning theory (BRT) perspectives on E-waste recycling and management. Journal of Cleaner Production, 280, 124269. https://doi.org/10.1016/j.jclepro.2020.124269

Eisenack, K. A. (2014). Climate Change Board Game for Interdisciplinary Communication and Education. Simul. Gaming, 44, 328–348

Fernandes, B., Biswas, U. N., Tan-Mansukhani, R., Vallejo, A., & Essau, C. A. (2020). The impact of COVID-19 lockdown on internet use and escapism in adolescents. Revista de Psicología Clínica con Niños y Adolescentes, 7(3), 59-65. https://doi.org/ 10.21134/rpcna.2020.mon.2056

Fernandez, G., Thi, T. T., & Shaw, R. (2014). Climate change education: Recent trends and future prospects. Disaster Risk Reduction, 53-74. https://doi.org/10.1007/978-4-431-55090-7_4

Finnegan, W. (2020, May 7). Environmental activism goes digital in lockdown – but could it change the movement for good? The Conversation. https://theconversation.com/environmental-activism-goes-digital-in-lockdown-but-could-it-change-the-movement-for-good-137203

Fioretti, J. (2014, July 2). EU unveils new recycling targets, landfill ban. Scientific American. https://www.scientificamerican.com/article/eu-unveils-new-recycling-targets-landfill-ban/

Grossberg, F.; Wolfson, M.; Mazur-Stommen, S.; Farley, K.; Nadel, S. (2015). Gamified Energy Efficiency Programs; American Council for Energy-Efficient Economy: Washington, DC, USA.

Guba, E. G., & Lincoln, Y. S. (1985). Fourth generation evaluation. SAGE.

Hamari, J.; Koivisto, J.; Sarsa, H. (2014)Does Gamification Work?—A Literature Review of Empirical Studies on Gamification. In Proceedings of the 2014 47th Hawaii International Conference on System Sciences, Waikoloa, HI, USA, pp. 3025–3034.

Halder, P., & Singh, H. (2018). Predictors of recycling intentions among the youth: A developing country perspective. Recycling, 3(3), 38. https://doi.org/10.3390/recycling3030038

Haron, S. A., Paim, L., & Yahaya, N. (2005). Towards sustainable consumption: An examination of environmental knowledge among Malaysians. International Journal of Consumer Studies, 29(5), 426-436. https://doi.org/10.1111/j.1470-6431.2005.00460.x

Huotari, K., & Hamari, J. (2017). A definition for gamification: Anchoring gamification in the service marketing literature. Electronic Markets, 27(1), 21-31. https://doi.org/10.1007/s12525-015-0212-z

Joshi, Y., & Rahman, Z. (2015). Factors affecting green purchase behaviour and future research directions. International Strategic Management Review, 3(1-2), 128-143. https://doi.org/10.1016/j.ism.2015.04.001

Karapanos, M., Borchert, T., & Schneider, A. (2017). The adoption of educational technology from the perspective of behavioural reasoning theory. Proceedings of EDULEARN17 Conference, 88-95. https://doi.org/10.21125/edulearn.2017.1020

Kaza, S., Yao, L., Bhada-Tata, P., & Woerden, F. V. (2018). What a waste 2.0: A global snapshot of solid waste management to 2050. World Bank Publications.

Kjeldskov, J., Skov, M. B., Paay, J., & Pathmanathan, R. (2012). Using Mobile Phones to Support Sustainability: A Field Study of Residential Electricity Consumption. In Proceedings of the ACM CHI 2012 Conference on Human Factors in Computing Systems (pp. 2347-2356). Association for Computing Machinery. https://doi.org/10.1145/2207676.2208395

Knol, E., & De Vries, P. W. (2011). EnerCities, a Serious Game to Stimulate Sustainability and Energy Conservation: Preliminary Results. ELearning Papers, 25. Retrieved from http://www.qeam.com/docs/EnerCities_QEAM_BV_Knol-De-Vries-EnerCities-article-eLearning-Papers.pdf.

Krueger, R. A., & Casey, M. A. (2015). Focus group interviewing. Handbook of Practical Program Evaluation: 4th Edition, 506-534. https://doi.org/10.1002/9781119171386.ch20

Lenzi, M., Vieno, A., Perkins, D., Santinello, M., Elgar, F., & Mazzardis, S. (2012). Family affluence, school and neighbourhood contexts and adolescents' civic engagement: A cross-national study. American Journal of Community Psychology, 50, 197–210.

Liamputtong, P. (2011). Focus group methodology: Principle and practice. SAGE. https://doi.org/https://dx.doi.org/10.4135/9781473957657

Madison, C. (2019, February 1). Teaching the new generation about recycling: Green initiatives for the youth of tomorrow. Voices of Youth. https://www.voicesofyouth.org/blog/teaching-new-generation-about-recycling-green-initiatives-youth-tomorrow

Mahmud, S. N., & Osman, K. (2010). The determinants of recycling intention behaviour among the Malaysian school students: An application of the theory of planned behaviour. Procedia - Social and Behavioral Sciences, 9, 119-124. https://doi.org/10.1016/j.sbspro.2010.12.123

Maltseva, K., Fieseler, C., & Trittin-Ulbrich, H. (2019). The challenges of gamifying CSR communication. Corporate Communications: An International Journal, 24(1), 44-62. https://doi.org/10.1108/ccij-09-2018-0092

Mazur-Stommen, S.; Farley, K. (2016). Games for Grownups: The Role of Gamification in Climate Change and Sustainability; Indicia Consulting LLC: Washington, DC, USA.

Morganti, L., Pallavicini, F., Cadel, E., Candelieri, A., Archetti, F., & Mantovani, F. (2017). Gaming for Earth: Serious games and gamification to engage consumers in pro-environmental behaviours for energy efficiency. Energy Research & Social Science, 29, 95–102. doi:10.1016/j.erss.2017.05.001

Narksompong, J., & Limjirakan, S. (2015). Youth participation in climate change for sustainable engagement. Review of European, Comparative & International Environmental Law, 24(2), 171-181. https://doi.org/10.1111/reel.12121

Nolan, J., & McBride, M. (2014). Beyond gamification: Reconceptualising game-based learning in early childhood environments. Information, Communication & Society, 17(5), 594-608. https://doi.org/10.1080/1369118x.2013.808365

Osman, A., Isa, F. M., Othman, S. N., & Jaganathan, M. (2014). Attitude towards Recycling Among Business Undergraduate Students in Malaysia. American-Eurasian Journal of Sustainable Agriculture, 8(13), 6-12. http://repo.uum.edu.my/13973/1/6-12.pdf

Portela, F. (2020). TechTeach—An innovative method to increase the students engagement at classrooms. Information, 11(10), 483. https://doi.org/10.3390/info11100483

Quiroz-Martinez, J., Wu, D. P., & Zimmerman, K. (2005). ReGeneration : Young People Shaping Environmental Justice. Movement Strategy Center (MSC).

Reynolds-Tylus, T., Quick, B. L., Bigman, C. A., & Williamson, L. D. (2021). An examination of teenagers' beliefs toward organ donor registration. Clinical Transplantation, 35(4). https://doi.org/10.1111/ctr.14237

Rhodes, E.; Axsen, J.; Jaccard, M. (2017) Exploring Citizen Support for Different Types of Climate Policy. Ecol. Econ., 137, 56–69.

Saunders, M., Lewis, P., & Thornhill, A. (2015). Research methods for business students. Prentice Hall.

Schwitzgebel, E. (2019). Belief. In E. N. Zalta (Ed.), The Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/archives/fall2019/entries/belief/>

Siwar, C., Hossain, A., & Chamuri, N. (2000). Waste recycling and scavenging: review of concepts and practices for waste minimisation in Malaysia [Paper presentation]. Conference on Environmental Management Issues and Challenges in Malaysia, Bangi: Universiti Kebangsaan Malaysia.

Sreen, N., Purbey, S., & Sadarangani, P. (2020). Understanding the relationship between different facets of materialism and attitude toward green products. Journal of Global Marketing, 33(5), 396-416. https://doi.org/10.1080/08911762.2020.1751370

Strydom, W. (2018). Applying the theory of planned behaviour to recycling behaviour in South Africa. Recycling, 3(3), 43. https://doi.org/10.3390/recycling3030043

Tan, B. C., & Lau, T. C. (2010). Attitude towards the Environment and Green Products: Consumers' Perspective. Management Science and Engineering, 4(2), 27-39. https://www.researchgate.net/publication/228500580_Attitude_towards_the_Environment_and_Green_Products_Consumers%27_Perspective

Tani, M., Gheith, M. H., & Papaluca, O. (2021). Drivers of student engagement in higher education: A behavioural reasoning theory perspective. Higher Education. https://doi.org/10.1007/s10734-020-00647-7

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 5 May 2022 doi:10.20944/preprints202205.0053.v1

Tobin, G. A., & Begley, C. M. (2004). Methodological rigour within a qualitative framework. Journal of Advanced Nursing, 48(4), 388-396. https://doi.org/10.1111/j.1365-2648.2004.03207.x

UNICEF. (2020, November 19). 9 out of 10 youth in Malaysia are already taking individual action to address climate change. https://www.unicef.org/malaysia/press-releases/9-out-10-youth-malaysia-are-already-taking-individual-action-address-climate-change

Uskov, A., & Sekar, B. (2014). Serious games, gamification and game engines to support framework activities in engineering: Case studies, analysis, classifications and outcomes. IEEE International Conference on Electro/Information Technology. https://doi.org/10.1109/eit.2014.6871836

Vanegas-Rico, M., Corral-Verdugo, V., Ortega-Andeane, P., & Bustos-Aguayo, J. (2018). Intrinsic and extrinsic benefits as promoters of pro-environmental behaviour. Psyecology, 9(1), 33-54. https://doi.org/10.1080/21711976.2017.1390034

Wang, Q., Zhang, W., Tseng, C. P., Sun, Y., & Zhang, Y. (2021). Intention in use recyclable express packaging in consumers' behaviour: An empirical study. Resources, Conservation and Recycling, 164, 105115. https://doi.org/10.1016/j.resconrec.2020.105115

Westaby, J. D. (2005). Behavioural reasoning theory: Identifying new linkages underlying intentions and behaviour. Organisational Behavior and Human Decision Processes, 98(2), 97-120. https://doi.org/10.1016/j.obhdp.2005.07.003