RESEARCH ARTICLE

REVISED Playing Edcraft at Home: Gamified Online Learning for Recycling Intention during Lockdown [version 2; peer review: 2 approved]

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v2 First published: 06 Sep 2021, 10:890
<https://doi.org/10.12688/f1000research.72761.1>

Latest published: 20 Dec 2021, 10:890
<https://doi.org/10.12688/f1000research.72761.2>

Abstract

Background: Gamification is an innovative approach to engaging in activities that people believe as less interesting. Recycling has been an issue not taken aware by the people in environmental sustainability. There are substantial studies on recycling intention due to the continual growth of unethical and unsustainable waste disposal. Creative approaches to recycling awareness activities should be made to fulfil youths' increasing interest in and demand for recycling. The main objective of this study is to explore the factors related to youths' recycling intentions after experiencing a gamified online recycling learning activity, Edcraft Gamified Learning (EGL). Gamified recycling education is believed to be a practical and engaging approach for youths.

Methods: 100 students participated in EGL, consisting of two levels of plastic crafting and recycling activities. They experienced online EGL at home between May and September in 2020, during the COVID-19 pandemic total lockdown in Malaysia, namely, Movement Control Order (MCO). 29 participants were selected to participate in five focus group discussions (FGDs) with five to eight participants per session to explore their opinions towards gamified learning, motivation and recycling intention.

Results: This paper reports the findings of the FGDs. A codebook was developed based on the codes from the FGD feedback. The codes were rated by two raters, followed by an assessment of inter-rater reliability and thematic analysis. The findings emerged and were confirmed with four themes as factors that influence recycling intention. They are gameful experience, social influence, intrinsic motivation, and extrinsic motivation.

Conclusion: The dependent variable, recycling intention, was connected to the four themes to verify the conceptual framework. One limitation of the study was the design of the EGL activity, which

Open Peer Review

Approval Status

	1	2
version 2		
(revision)		
20 Dec 2021	view	view
version 1		
06 Sep 2021	view	view

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was only carried out over two days with two levels of gamified recycling education, as students had concurrent academic online classes during that period.

Keywords

Recycling intention, Gamified learning, Youth, Digital natives, Qualitative, Focus group discussion, Edcraft, Inter-rater reliability

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Competing interests: No competing interests were disclosed.

Grant information: This work was supported by Special Mini Fund MMUI/180244.02 and SDEC Support by Multimedia University Malaysia and Xiamen University Malaysia Research Fund under Grant XMUMRF/2021-C8/IECE/0023.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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How to cite this article: Cheng KM, Koo AC, Mohd Nasir JS and Wong SY. **Playing Edcraft at Home: Gamified Online Learning for Recycling Intention during Lockdown [version 2; peer review: 2 approved]** F1000Research 2021, 10:890 <https://doi.org/10.12688/f1000research.72761.2>

First published: 06 Sep 2021, 10:890 <https://doi.org/10.12688/f1000research.72761.1>

REVISED Amendments from Version 1

This version has been updated slightly on the abstract, specifically the first two sentences. The Literature review has added a new section on gamification in learning where it gives an introduction to the gamification domain. Then, in 2.2, Table 1 has been edited, two columns have been added to the table. The study type is on the methodology, the recommendation is the potential of gamification in waste management and recycling behaviour. Following is the conceptual framework whereby the explanation has been added for better coherency. In Methods, the activity EGL has been explained in detail and a new figure, Figure 2 also been added to show the flow of EGL activity. Previous version Figure 2 is now Figure 3.

In 3.1 data analysis, the 6 phases of thematic analysis have been added to show the 6 steps of thematic analysis that has been implemented. All sections starting from 3.1.1, to 5 have been included with each step from the 6-step thematic analysis. In section 4.1, themes and categories, all subsections have added some info to further explain the analysis of each theme. Lastly, in section 5 - implication and conclusion, detail like game elements that contributed to the study and led to recycling intention was explained. Quantitative research that has been reviewed in Table 1 were discussed which has higher potential to explore the effectiveness of recycling behaviour.

Any further responses from the reviewers can be found at the end of the article

1. Introduction

Most countries have long ago adopted recycling to preserve the environment's health, which is often related to human health aspects.¹ Recycling behaviour has promoted a positive attitude towards the environment within society. Around the world, municipal waste production correlates with a country's economic growth. Statistics show that pro-environmental behaviour, awareness, and intentions are the most direct measures for coping with daily household waste production. Nonetheless, plastic packaging increased 53% internationally during the lockdown in the pandemic situation between March and June 2020.²

Studies conducted in 2017 and 2018 show negative attitudes of the individuals like the lack of participation, feeling less responsible and not being aware of recycling in many countries have claimed that recycling education and infrastructure are insufficient.^{3,4} However, the negative attitudes had caused severe environmental destruction, as they are often more reactive and 'always forgot' or 'do not care' about the act of recycling when there is no support from recycling infrastructure, facilities or programmes.⁵

This research aims to examine the factors that influence youths' recycling intention after experiencing a gamified online learning activity, Edcraft Gamified Learning (EGL), and to explore the effectiveness of gamified learning about recycling within a research framework.⁶

2. Literature review

2.1 Gamification in learning

Gamified learning is a term that refers to the fusion of gamification and education. It is, in essence, the application of game-design elements and game principles to the context of learning. Gamification has primarily been used in education to increase motivation for tasks or activities that are frequently perceived as boring or less enjoyable, particularly given that motivation is a significant predictor of students' academic achievement. Gamified learning's primary goal is to maintain learners' engagement and motivation, as well as to assist learners in achieving their learning objectives while having fun. Gamified learning is a process in which the traditional classroom methodology is transformed into a well-designed, enjoyable classroom environment through the incorporation of game design and game-like experiences into the learning processes. It is a strategy for facilitating effective learning by involving learners in game-like elements such as challenges (levels, missions), competitions (leaderboards), and recognitions (points, rewards).

Learning can take place on any subject, but this study focuses on recycling, which is also an action that contributes to environmental sustainability.

2.2 Youths as agents of change

Youths between the ages of 15 and 24 comprise 17% of the world's population, and they are the critical agents of change for the future, especially on climate change.⁷ Youth has been understood as the responsible group to bring the benefits of society in the world, taking its place in attitudes, behaviours, knowledge and skills.⁶ Greta Thunberg, a young climate and environmental activist, continues to lead, promote and motivate young people's awareness and behavioural changes towards pro-environmental actions. She encourages her followers to use digital platforms for pro-environmental awareness and actions.^{8,9} Thunberg's actions have also influenced some Malaysian youths to take climate action locally,

such as that taken by Klima Action Malaysia (KAMY).¹⁰ The youth-led green and climate movements have created a new revolution for positive environmental change, as evidenced by their influence and leadership on social media.

2.2.1 Youths as digital activists for positive change

Youth populations are exposed to vast amounts of information, and multimedia and social media are recognised by these “digital natives”.¹¹ The long hours youth spent online surfing the internet, socialising and playing video games in the virtual world during lockdowns due to the pandemic has increased tremendously. The long period spent by the youths in the virtual world has created an effective platform to influence their peers through video games and social media.

Studies have shown that youths opt to spend time playing video games online to avoid adverse psychological effects while confined at home during the pandemic.^{12,13} Young people should be exposed to positive activities to create an impact for any form of good cause, including pro-environmental initiatives. The initiatives can be done online, as demonstrated by youth leaders such as Thunberg and KAMY.

2.3 Recycling and gamified learning

Waste separation and recycling are methods to curb problems associated with environmental hazards. Recycling is also a way to save economic and environmental resources. Hence, the importance of recycling behaviour has been studied, and it has been found that one of the most critical factors for achieving the effectiveness of recycling programmes is public participation,³ which was studied by this research as people’s intention to participate in recycling. Recycling is seen as problematic by some, who may perceive it as time-consuming and something that requires considerable effort.^{14,15}

Germany and Sweden are among the countries that were positively impacted by their recycling programme in educating and engaging the people in waste separation and reached 90% of active participants in waste separation activity.^{16,17} Gamified learning is considered to engage people in recycling, and Table 1, below, shows four different gamified environmental education programmes.

Table 1. Review of studies of gamified learning research in the recycling area.

Gamified learning recycling research	Study type	Findings	Recommendations
Make waste fun again! A gamification approach to recycling ¹⁸	Qualitative, focus group discussion (n = 25, older male participants, younger adults, students and younger and elderly)	Feedback, awards, achievements, collaborative and competitive features from video games are all important in closing the gap between waste management behaviour and knowledge.	Waste management can engage with the game elements applied in the social mechanism.
How to encourage recycling behaviour? The case of WasteApp: a gamified mobile application ¹⁹	Quantitative, questionnaire survey (n = 79, industry experts with different professions)	Adopting a gamified sustainability app directly and significantly impacts the intention depending on the expected social benefits and perceived risks.	External factors from friends and colleagues affect the intention of the use of gamified technology can achieve better recycling behaviour
Advocating recycling and encouraging environmentally friendly habits through gamification: An empirical investigation ²⁰	Quantitative, questionnaire survey (n = 457, users of recyclebank.com website)	The gamification website's engagement positively affects the cognition- and affect-based attitudes and satisfaction in improving users' recycling behaviors and behavioural intentions.	Incorporating gamification in technology can improve an individual's attitude towards recycling intention.
Incentives for Plastic Recycling: How to Engage Citizens in Active Collection. Empirical Evidence from Spain ²¹	Quantitative, questionnaire survey (n = 1053, families)	Results show people can be influenced and their recycling habits changed through varied, effective, and innovative incentive schemes.	An innovative solution like gamification is important to raise environmental awareness and should be rewarding.

Figure 1. The conceptual framework showing four key themes or concepts related to recycling intention.

From the findings in Table 1, the common traits of gamified environmental awareness learning are that gamification can potentially influence the adoption of a positive recycling intention.

Recycling intention

Some people perceive recycling as a time-consuming activity. This study will make use of gamification to engage the youth involvement in recycling, and change their “always forgot” and “do not care” attitude towards recycling intention.⁵

2.4 Conceptual framework

In Figure 1, the study has conceptualised a framework of recycling intention initiated by gamified learning. It was conceptualised that the youths’ motivation is crucial to recycle and requires the intrinsic motivation (e.g., satisfaction, happiness or enjoyment, and extrinsic) motivation, e.g. (monetary reward, promotion or punishment) evoked from the gameful experience to influence their family and friends. Besides, a gameful experience is also believed to directly influence youths’ families and friends from the game elements that are competitive and challenging.

With the assistance of gameful experience, the youths will be motivated intrinsically and extrinsically and socially influenced the peers and family members to recycle.

There are two research questions (RQ) from the research:

- 1) How effective is the online gamified recycling activity towards youths’ recycling intention?
- 2) What are the factors of recycling intention that leads to the research conceptual framework?

3. Methods

The qualitative study relates to the two-level online gamified recycle crafting activity, namely Edcraft Gamified Learning (EGL) activity during the COVID-19 pandemic lockdown between May and September 2020. EGL is an online gamified activity that uses game elements (levels, points, leaderboard, and rewards) to create a craft from a recyclable item, such as used plastic.

This activity involved 100 youths from three institutions, one high school and two colleges in Selangor, Malaysia, who were 16–23 years old and staying at home due to the pandemic. Participants were recruited from their schools and colleges through the activity recruitment poster and “Word-of-Mouth” from the teachers and lecturers. They provided written consent to participate on the day of the activity and were informed that the data would be for research and publication use.

Participants were required to undergo two days and two levels of crafting activity. Next, participants were to watch a video tutorial about the recycling craft for a basic idea to accomplish level 1 recycling craft, and they were given a day to

Figure 2. Overview of Edcraft Gamified Learning (EGL) activity flow.

work on each craft freely and creatively. The next day, participants proceeded to level 2 with the same procedure as level 1 but with a higher difficulty recycling craft. Then, their crafts will be evaluated by art teachers and ranked on a leaderboard. The participants who were ranked on the leaderboard will receive certificates and prizes. After experiencing two-level EGL, 29 students were purposively selected as FGD participants. Participants with excellent achievement, commitment and attention to the activity were selected for the FGD. **Figure 2** shows the overview of the EGL activity flow.

3.1 Thematic analysis

Braun and Clarke (2006) formulated a six-phase approach in the thematic analysis and was used in this qualitative analysis of the FGDs to identify, organise, describe, and report themes for trustworthiness.²² In the first phase, to familiarise the data, the transcriptions were annotated and reviewed for a second time, then in the second phase, the coding stage, a coding assessment was done from the interview data to obtain the code's reliability. In third phase, the reviewed 37 codes were further sorted into 13 categories and generated into the themes based on repeated patterns and similarities in their nature. In the fourth phase, initial themes were further reviewed to check if they are making sense to the research, and the themes will be going for a final refinement in the fifth phase to gain insightful and accurate findings that match the research questions. Finally, in sixth phase, the findings from the analysis will be discussed and reported.²³ Each of the phases will be explained in the following sections.

3.1.1 Prior to data analysis

Recordings were made of each of the five online FGD sessions. Each session lasted for 50–70 minutes, and could be listened to for a second time to identify recurring data patterns. Participants were given instructions beforehand and were informed several days before the FGD. The researcher was also given consent by each of the participants to conduct the FGD sessions.

In the first phase of the thematic analysis, the recorded sessions were transcribed from audio to text. Later, the transcripts were familiarised with annotation to the transcripts. Then, in second phase, the initial coding was done and compiled into a codebook for inter-rater reliability assessment.

3.1.2 Coding assessment

Inter-rater reliability assessment

To obtain code consensus from the raters, the degree of agreement scores, 0 and 1, were measured by two raters. Both raters were trained to perform their task by identifying the target behaviour from the transcripts.²⁴ According to,^{25,26} the value of 0.78 in **Table 2** shows the kappa statistics of agreement that were analysed by the IBM Statistical Package for

Table 2. Kappa statistics of agreement.

Symmetric measures				
	Value	Asymptotic standard error ^a	Approximate T ^b	Approximate significance
Measure of agreement kappa	0.786	0.206	4.895	0.000
N of valid cases	37			

^aNot assuming the null hypothesis.

^bUsing the asymptotic standard error assuming the null hypothesis.

Social Sciences Statistics (SPSS) Version 26 software (IBM SPSS Statistics, RRID:SCR_019096). An open source alternative to SPSS is GNU PSPP. The statistics show substantial or very good agreement relative to the kappa statistics.

4. Results and discussion

Twenty-nine students from the FGDs shared their insights, responses, opinions, and experiences online on how they acted towards the recycling issue in Malaysia, during the COVID-19 pandemic. For the third phase, four themes were obtained from the participants' responses from the 13 categories that were sorted from the 37 codes. The four themes are characterised as the independent variables or factors influencing the youths' recycling intention. They are as follows:

- 1) Engagement with the gamified recycling activity,
- 2) Intrinsic motivation,
- 3) Extrinsic motivation, and
- 4) Social influence.

Recycling intention is the dependent variable. All responses from the four themes were to answer RQ 1, explore the effectiveness of online gamified recycling activity that leads to recycling intention and verify the conceptual framework in Figure 1.

4.1 Themes and categories

In this section, each theme was listed and reviewed based on the participants' FGD responses as the fourth phase of the thematic analysis. Insights from the interviews were highlighted to create a progressive construct on the conceptual framework to explore the ideas and meaning from the participants. All the verbatim were directly quoted from their original meaning.

4.1.1 Engagement from gamified Learning activities

When the researcher asked about their engagement in gamified learning activities, two participants think that with gamification applied, they get engaged by the competition and do not want to stay behind the rank. Participant P said it is crucial not to fall behind and feel ashamed. Therefore, they tend to work harder: "Yeah I think it is very important if not I will also would like you know so like I actually put more effort." Participant R, too, was engaged because of their friend's ranking and they valued the interaction between peers: "Your friend has a higher ranking and ... work a little bit harder to get a higher rank...".

Moreover, participant Temphasise the used of gamification in the activities have engaged him to work towards different challenges. He stated that "We use game to compare...then it will have missions to work on, then it has the leaderboard from it, and reward, all has it in the Edcraft. I think this fulfills the standard of gameful." Participant T had experienced video games and compared the fun of the gamified learning activity to a video game.

4.1.2 Intrinsic motivation

Participant K made a strong statement about the accomplishment of the EGL activity: "Yes, I feel it gives me the sense of accomplishment ... I keep on doing...about 6-7 hours until I upload the video ... I feel the sense of accomplishment...". Four participants felt the happiness from accomplishment more than obtaining the physical reward. Recognition has intrinsically motivated the students, and they appreciate what they have earned through hard work. "I think rewards are important ... certificate they will be useful ... I think you can put it in your resume." Additionally, enjoyment is part of the

participants' emotions. They immersed themselves in the activity and felt a sense of pleasure. Participant O was triggered by the activity and enjoyed the process of making a craft out of unused recyclable items: "After participated the Edcraft ... it taught me that bottle can turn into other things..."

4.1.3 Extrinsic motivation

Based on the responses, 8 participants stayed motivated to the end of the activity because they were promised a certification and prizes as rewards for completion. A reward is a form of extrinsic motivation as a temporary driver for them to recycle for participant J, and the external reward is a boost for the participant to achieve his dream as an artist. Therefore EGL, giving him a significant boost of motivation from the reward: "I am aiming for the certificate ... the cert is very important..." Participant Q mentioned motivation from rewards: "I think after organising Edcraft, it will cultivate the awareness of recycling. Just like vase they need to create by themselves, need to spend money and expensive. If use plastic, it looks beautiful and quite practical as well." This response shows that the participant appreciates their crafting and shaping their confidence to recycle.

4.1.4 Social Influence

Participants are competitive when they try their best to earn a reward within a challenging environment among a group of friends. 16 of the 29 youths from the FGDs have expressed their thought about the importance of social influence. Peers influenced each other to reach the same goal, and EGL has shown its social influence in competition: "I think it kind of affects in a positive way for youth ... you will feel like want to do better than them." Some participants take competition, points and rankings seriously: "I have some friend, first round only got 11 points then second round same points as me 41 points ... they are so serious, persist and not giving up."

They showed a solid feeling for overtaking their friends, and for them, the position in the rank is important for them not to stay behind. This situation has shown the youths' strong purpose to stay on par with their peers.

4.1.5 Recycling intention among youth

Participant A agreed that habit plays a role in recycling. "That is because they just do it all in habit ... we do have like a monthly sort of activity in our community." This clearly demonstrates that Participant A has done recycling for some time and is committed to the activity due to habit. Likewise, Participant D shows the expression of habit, saying, "every year always got talk about environment and the 3R so that's how we all grew that habit of recycling ..." There is a participant who believes that recycling is an activity that needs to be cultivated from an early age, following role models such as teachers, parents and friends. According to Participant F, "what motivates the young people to do recycling mostly comes from family. If your family practice then the children would probably just follows."

Two participants mentioned that they need to follow teachers' rules or get punished. Recycling has been an activity for the sake of rules or orders from elders: "teacher will punish the class which is not doing recycling ... the person will receive punishment by sending to recycling center to wash recycling item." This statement clearly shows that they recycle not because of its advantages but to avoid getting punished. Participant K loved the idea of an online EGL recycling activity: "I think after organising Edcraft, it will cultivate the awareness of recycling ... If use plastic, it looks beautiful and quite practical as well." By having EGL, recycling awareness awakened participants' thoughts about having fun recycling, and they have never thought that recycling items that many perceived as "trash" could be crafted into various practical and decorative items. In the beginning, recycling was a school activity, and punishment was imposed on them as enforcement, but after EGL, the purpose of recycling was clear, and they also learnt to repurpose recycling item instead of throwing it as trash.

4.2 Factors influencing recycling intention

Five topics from the FGD based on the codes and categories were finalised and defined the four themes, which is the fifth phase of the thematic analysis:

- 1) Gameful experience,
- 2) Intrinsic motivation,
- 3) Extrinsic motivation, and
- 4) Social influence.

Figure 3. Verified conceptual framework categorised into four themes.

The four main themes are the main factors influencing recycling intention to address RQ 2.

The responses show that participants were engaged with the activity. They felt the fun of the video game-like experience and were socially influenced by competition among their friends to get into the action of recycling and recycling intention.

The collected data and themes were used to verify, enrich and create the “flow”, referring to the conceptual framework in Figure 1 and factors that influence recycling intention from RQ 1 to address RQ 2, as shown in Figure 3. The following section will be on the sixth phase of the thematic analysis, where the implication and conclusion were discussed and reported from the above thematic analysis.

5. Implications and conclusion

Young people are part of social change, and they bring an impact to the betterment of the environment through recycling activities. Incorporating gamified learning to improve recycling intention can be brought about through social influence and intrinsic and extrinsic motivations. The elements of games like leaderboard, levels, points and rewards are significant to develop an engaging and purposeful activity to attract the youth to participate in recycling. Based on the responses from the youths, the most prominent one is on social influences. From the FGDs, 16 out of 29 youths think that competition and leaderboard are highly affecting peers to work towards a goal. They are often feel challenged to perform their best to not lag far behind those with better achievements. This factor is believed to pose a significant role in encouraging recycling intention among youths. Besides, to further explore the relationship between gamification, motivation and recycling intention. The quantitative research method is also a reliable way to investigate the effectiveness of gamification in recycling behaviour, as shown in Table 1. Therefore, this leads to a higher potential for future studies on quantitative methods.

This study serves as a starting point for researchers to explore the elements influencing youths’ intention and behavioural change. The method used in this study is FGDs. This research used inter-rater reliability on the coding agreement and the six phases of thematic analysis to reduce ambiguities and develop quality themes and frameworks that lead to well-grounded gamified online recycling learning. However, recycling activity requires commitment, and the two-day, two-level activity represented a short time for attitude development. It is hoped that with the incorporation of gamified online learning, the impact of social influence on pro-environmental awareness and recycling, similar to the achievements of Greta Thunberg and KAMY, can spread to more young people around the world. Cultivation of recycling behaviour requires a longer-term gamified activity to effectively close the gap between fun learning and recycling intention.

Data availability

Underlying data

OpenDans: Online Gamified Learning: Focus Group Discussion Data set, May - August 2020. <https://doi.org/10.17026/dans-xzu-as8s>.²⁷

This project contains the following underlying data:

- Data file 1. (Cohen kappa reliability output in.spv format)
- Data file 2 to 6. (Focus Group Discussion Transcription in pdf.)
- Data file 7 to 10 (interrater reliability in.doc, .dat, .sav, and.sps format)
- Data file 11 (invitation letter for interrater)

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver](#) (CC0 1.0 Public domain dedication).

Ethical approval

Ethical approval (EA) number from Multimedia University (approved by secretariat of Research Ethics Committee): EA2642021.

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27. Cheng KM: **C (Multimedia University) (2020): Online Gamified Learning: Focus Group Discussion Data set, May - August 2020.** *DANS.*
[Publisher Full Text](#)

Open Peer Review

Current Peer Review Status:

Version 2

Reviewer Report 21 December 2021

<https://doi.org/10.5256/f1000research.78749.r100362>

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Ariffin Abdul Mutalib

Multimedia, Innovation, and Digital Humanities Research Unit, School of Multimedia Technology and Innovation, Universiti Utara Malaysia, Sintok, Malaysia

The improvement is accepted for indexing.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: HCI, Usability, Multimedia in Teaching and learning

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 20 December 2021

<https://doi.org/10.5256/f1000research.78749.r116167>

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Herdiyan Maulana

Faculty of Psychology, Universitas Negeri Jakarta, Jakarta Selatan, Indonesia

I am happy with the authors revision. Their paper now is ready for full indexing.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Thematic analysis study, Well-being, Online mental health services, well-being, social psychology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 17 November 2021

<https://doi.org/10.5256/f1000research.76364.r96007>

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Ariffin Abdul Mutalib

Multimedia, Innovation, and Digital Humanities Research Unit, School of Multimedia Technology and Innovation, Universiti Utara Malaysia, Sintok, Malaysia

In general, the paper sounds like an empirical study, but the process does not sound technically sufficiently. Please consider the following to improve the paper:

1. The introduction can be better addressed by discussing the domain of study first, followed with the context of the study. The aim of the study should be stated in the section as well.
2. The literature review should also focus on the domain of study, showing the gap (that the study taps into).
3. The methods are too general and lack justification. Some parts need strong justifications, like sampling.
4. The results and discussion are too brief. Perhaps, you can focus on one factor and discuss more deeply.
5. Implications should compare the findings in this paper with those previously found by others.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

No

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Human-Computer Interaction

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 07 Dec 2021

kinmeng cheng, Multimedia University, Cyberjaya, Selangor, Malaysia

1. I have strengthened the abstract, introduction and included gamified learning to guide the readers on domain of study.
2. Literature has been enriched with gamified learning and recycling.
3. Methods has been strengthened with a clearer explanation of the EGL activity and a new Figure 2 to show the flow of the data collection activity.
4. Results and discussion has improved accordingly and social influence has been addressed, deeper meaning based on the results.
5. Implications have shown that the research from table 1 can be a potential reference for future expansion of the study for quantitative research. The four themes have been further discussed in the conclusion and implication section.

Competing Interests: No competing interests were disclosed.

Reviewer Report 09 September 2021

<https://doi.org/10.5256/f1000research.76364.r93524>

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Herdiyan Maulana

Faculty of Psychology, Universitas Negeri Jakarta, Jakarta Selatan, Indonesia

I appreciate the authors for bringing a very interesting yet important research theme into the table. The paper presented an insightful message about the potential uses of gamified based intervention to enhance youth recycling intention. However, there are number of concerns about the way in which the paper is presented. The following suggestions are intended to assist the authors in improving the quality of their paper.

1. The introduction need to be refined, there are numbers of unclear and inefficient sentences:

1) *"Most countries have long ago adopted recycling to preserve the environment's health."* This sentence is ambiguous, what do the authors mean by the environment's health? This sentences also need for further grammar check.

2) The sentence in paragraph 2 *"A study conducted in 2017 and 2018 shows a negative attitude towards recycling in many countries, claiming that recycling education and infrastructure are insufficient"*. The authors indicated "A study" but the citation refers to two different studies. This sentence also not clear, what do the authors mean by "a negative attitude?" please clarifiy.

2. Table 1. needs to be clarified. It may an idea to add study type, findings, and recommendations column for cited papers.

3. I also notice that some papers included in Table 1. did not clearly state the effectiveness of gamified method as a potential way to enhance people's recycling intention. e.g. Study by Betaubun & Nasrawati (2020), which according to the author, can be used as a reference to show the use of gamified approach for enhance recycling intention, was as a cross-sectional study. To provide strong evidences for the potential used of gamification method to enhance recycling intention, I suggest the authors to cite an experiment based publications.

4. As this is a qualitative study, a research question addressing the effectiveness of the program might be problematic. Objective indicators and systematic measures should be applied to answer if the program is really effective. Rather than testing the effectiveness, this study may focus on describing subject's subjective experiences using the program, and how their experiences benefit for developing the program. Further, the author may describe in more detail about the game itself. Why and how the game is delivered, e.g., duration, elements, self-guided or full-guided, online/offline, and system requirements of the program.

5. Braun & Clarke (2006) thematic analysis comprises series of steps when analyzing the qualitative transcriptions. The steps including how the authors develop low-order and high order themes. Please consider to explain the analysis steps in more detail.

6. The authors may need to explain in a bit more detail about the conceptual model (figure 2). How did the authors come up with this model? What thematic analysis results lead to this model?

7. Suggestion to test the model using quantitative method should be added.

References

1. Betaubun M, Nasrawati N: English for Specific Purpose: Revitalizing Climate Change Awareness Using Digital Literacy and Gamification for Engineering Faculty in Papua. *Jurnal Iqra' : Kajian Ilmu Pendidikan*. 2020; **5** (2): 68-82 [Publisher Full Text](#)
2. Braun V, Clarke V: Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006; **3** (2): 77-101

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Thematic analysis study, Well-being, Online mental health services, well-being, social psychology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 07 Dec 2021

kinmeng cheng, Multimedia University, Cyberjaya, Selangor, Malaysia

Thank you so much for the review. I have made the changes accordingly based on the comments.

1) Unclear statements regarding to environment's health and sentence coherency have been changed and clarified.

2 and 3) Table has two new added columns on study type and recommendations. I have

removed the study by Betaubun & Nasrawati (2020) and replaced it with a new empirical article "Advocating recycling and encouraging environmentally friendly habits through gamification: An empirical investigation" which provides stronger evidences for the effectiveness of gamification in recycling intention.

4) I have enriched the conclusion and discussion part to show how the EGL effectively improves youths' motivation to recycle. Social influence is emphasised in several sections of the paper.

5) 6 phases of thematic analysis have been added in 3.1 and leading each of the steps in the following sections to provide a clearer reading for the readers.

6) Additional explanation and improvement on the conceptual framework part.

7) Suggestions for future quantitative study have been added.

Competing Interests: No competing interests were disclosed.

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