A Study Evaluating the Effectiveness of Game Design and Development in Promoting Sustainable and Pro-Environmental Behaviours amongst Higher Education students

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Hannah Kelly studied BSc Geography at the University of Lincoln and graduated in 2021 with a First-Class honours degree. This piece of research was undertaken between June 2020 and December 2020 for her third-year dissertation and was supervised by Dr Theresa G. Mercer and Dr Andrew P. Kythreotis.

Abstract

Globally, exponential population growth has increased public demand and pressures on natural resources, and consequently, terrestrial, biological and human ecosystems have suffered. Therefore, it is important that people understand the impacts they have on the environment and to encourage them to adopt more sustainable and pro-environmental behaviours. To accomplish this, there has been an emphasis on educating future generations through Education for Sustainable Development (ESD) within the National Curriculum using unique ways of capturing student engagement such as through Game Based Learning. However, as students' progress through the education system the incorporation of, and engagement with, ESD diminishes. Therefore, this article examines and evaluates the effectiveness of game design and development in learning about and promoting sustainable and pro-environmental behaviours in Higher Education (HE) students.

In 2020 University of Lincoln third year Geography students were tasked with creating an environmental game based on an environmental issue of their choice. Upon completion of the game designs, the students were surveyed to ascertain whether the game design and development process deepened their knowledge and understanding of environmental issues and as such impacted their sustainable and pro-environmental behaviours. Results indicate that most of the students found the creativeness and uniqueness of the assessment style to be engaging and that, to some extent, the game design and development assessment did

positively impact their sustainable and pro-environmental behaviours. This article adds new empirical insights into the ways in which game design and play can contribute to encouraging pro-environmental behaviour in HE students.

Key Words:

Education for Sustainable Development, Higher Education, Sustainable Behaviours, Pro-Environmental Behaviours, Game Based Learning, Game Design, Game Development

1: Introduction

1.1: Sustainable Development Overview

As the world has become more populated, and countries have experienced substantial economic growth, there has been a rapid increase in urban development and extensive resource use alongside other anthropogenic activities which have had detrimental impacts on the environment (Danish et al., 2019). However, as more is known about the impacts of anthropogenic activities on the earth's natural and human ecosystems there has been an increased focus on sustainable development (SD) and sustainable practices in order to reduce the impact of urban (ergo economic) growth on the environment (Danish et al., 2020).

1.2: Education for Sustainable Development and Game Incorporation Overview

A key contemporary (and arguably innovative) initiative used to promote SD (or sustainability) is Education for Sustainable Development (ESD). ESD is a dynamic, interdisciplinary concept that aims to educate and raise awareness about environmental, social, and economic issues arising from SD in order to promote more sustainable behaviours (Sinakou et al., 2017). As such, it has been argued that through ESD people can become more aware of the impact of their lifestyle choices, and the associated consumptive behaviour on the environment, leading to a more equitable society over time. As a result, ESD should be incorporated within all stages of education around the world as younger generations are seen to be important "agents of change" (Walker, 2016, 74), with students being credited to cause a "Multiplier Effect" in which whole communities can learn to become more sustainable as students can disseminate what they have learnt in school, college or university (Mochizuki and Bryan 2015, p. 8).

Despite this, for ESD to be successful students need to be stimulated and encouraged to think critically about environmental impacts (Mulà et al., 2017). Recent research has identified that an effective strategy is student-led, game-design and game-based learning (GBL) as this gives students opportunities to research environmental issues and incorporate these topics through hands on activities, which can lead to increased sustainable and pro-environmental behaviours (Mercer et al., 2017; Madani et al., 2017; Hsieh, 2020). There has already been a substantial amount of research exploring how primary and secondary school students interact with ESD and GBL, as well as the impacts it has on their environmental behaviours. Key studies in this field include those by Pramling Samuelsson (2011), Otto and Pensini (2017), Olsson and Gericke (2015) and Winter (2007). As such the incorporation of ESD within school curricula has been widely recognised to positively impact behaviours as students are encouraged to think more critically, ask questions and apply their knowledge to "envision more positive futures" (Laurie et al., 2016, 231); However, the integration of ESD into Higher Education (HE) is more of a challenge and as game development is a relatively new concept in promoting ESD, there is limited research on how HE students interact with this form of learning and whether game development influences them to adopt more sustainable and pro-environmental behaviours.

1.3: ESD and Higher Education

As universities are an integral part in shaping future societies, and preparing students to overcome future challenges, the complexity of university systems has meant there has been a lack of ESD at this level of education (Lozano et al., 2013). This is highlighted by Sterling and Scott's 2008 study which reviewed ESD provisions within universities from 1990 to 2008. It concluded that though there were attempts to include ESD, universities were often resistant to government initiatives. As a result, the level of ESD embedded was dependent on individual universities and was impacted by a range of factors including a lack of budget, lack of understanding and a lack of motivation between both staff and students (Leal Filho et al., 2018).

Despite this, there has been a substantial drive to incorporate ESD within HE. To support this drive, QAA and Advance HE has published new guidance on how HE institutions can include ESD across their curricula by targeting guidance at staff and senior management (QAA, 2021). Similarly, student interest in sustainability has led to a demand for the incorporation of ESD within the courses offered by HE providers (Mulà et al., 2017). Many studies have found that whilst HE students demonstrate pro-environmental and sustainable

behaviours, few studies have researched if they, (HE students and ESD), interact with each other in order to promote these behaviours, though this a complex area as other factors can influence behaviours.

Vicente-Molina et al (2013) studied the responses of 2,226 HE students worldwide and found that though all of the students displayed pro-environmental behaviours, the levels varied between countries demonstrating that pro-environmental behaviours differ between cultures; emphasising that effective ESD needs to be diverse and inclusive to encompass people from all backgrounds. Similarly, Vicente-Molina et al (2013) and Leal Filho et al (2018) found that student's perceived own knowledge of environmental issues was higher than their actual knowledge, showing that ESD needs to focus on equipping students with factual knowledge to allow them to make the right pro-environmental and sustainable choices, which in turn will allow them to pass on their knowledge.

1.4: Games and Higher Education

It has been argued that an effective way for HE students to increase their own pro-environmental behaviours, is to involve them in 'project-based' activities as these provide students with practical skills as well as knowledge in order to allow them to effect change in their own environmental behaviours (Reisz, 2020). An innovative way of facilitating this is by involving HE students in the development of educational tools, in particular educational games. This concept is explored by Hsieh (2020) who found that the game design process allowed students to learn about and discuss local environmental and sustainability issues in order to devise possible solutions. The results of the study found that the incorporation of environmental and sustainability issues into games positively influenced the pro-environmental and sustainable behaviours of both the students and the players and encouraged 'multi-faceted thinking'.

Mercer et al. 2017 also explored how the creation of educational tools can influence HE students' sustainable and pro-environmental behaviours. This study was two-fold; firstly, it addressed the use of educational games in encouraging primary school children to become interested in sustainability and environmental issues and the second part focused on the design and development of environmental games by university students. Mercer et al (2017) argued that the students would be able to challenge their own knowledge and understanding of environmental issues when creating their own age-appropriate games. This novel approach

allowed the HE students time to experientially reflect on their own behaviours towards the environment and positively influence their pro-environmental and sustainable behaviours.

Overall, there has been an abundance of research relating to the incorporation of ESD and game design and development in both primary and secondary education and that, in comparison, HE students have less opportunity to engage with these concepts (Cravero et al., 2021). Similarly, many studies have shown that there is limited research into how game-design influences HE students' pro-environmental and sustainable behaviours. As a result, this article will evaluate the effectiveness of game design and development in promoting sustainable and pro-environmental behaviours in HE students by exploring three research questions:

RQ1: How do HE students engage with environmental game assessments?

RQ2: Are environmental game assessments an effective platform for learning about sustainability?

RQ3: Have the environmental game assessments positively influenced the pro-environmental and sustainable behaviours of the HE students?

2: Methodology

This research was conducted for a third-year dissertation (Kelly, 2021) and was based on a University of Lincoln third-year Geography module, called 'Environmental Management'. This module used a range of interdisciplinary and practical techniques to highlight important human and environmental issues on a range of spatial scales, from global to local case studies. The module also encouraged the students to think of ways to solve and reduce these problems.

One of the main outcomes for this module was to educate HE students on sustainability and ways in which they can promote their own sustainable and pro-environmental behaviours. This outcome was subsequently applied in the module's formal assessment which required the students to develop and make an educational game based on an environmental problem of their choice, with the intention of the game being used as an educational tool to educate and promote sustainable and pro-environmental behaviours in a secondary education setting.

This research was an extension of the 2017 study by Mercer et al, which observed how HE students engaged with game design and development in order to promote pro-environmental behaviours. As a result, this research compared HE student responses obtained from that study as supplementary data.

This research involved third-year geography students from the University of Lincoln, who undertook the 'Environmental Management' module between 2019 and 2020.

2.1: Data Collection

Upon completion of the Environmental Management module the students completed a questionnaire which surveyed their engagement with the game development assessment and whether they perceived that their own sustainable and pro-environmental behaviours had changed as a result.

The questionnaires consisted of two sections. Section one was titled 'About the environmental game assessment' and gathered responses relating to how the students viewed and engaged with the game assessment itself, whereas section two was titled 'Changing attitudes, behaviours and skills.' This section focused on how the assessment influenced the students' behaviours towards sustainability and their own pro-environmental behaviours, as well as ascertaining whether they had improved any other skills.

Open-ended questions were used as they provided a detailed insight into how the HE students viewed and perceived the game assessment, as well as their opinions on whether they had noticed a change in their own sustainable and pro-environmental behaviours. These more in-depth answers were then sifted and coded into various themes (see 2.3).

Closed questions were also used in this research in the form of Likert Scale responses as they allowed the HE students to pick the most appropriate answer and when assessing the student's changes in skills a Grid/Matrix table was used.

2.2: Data Analysis

The results of the questionnaires were organised according to response rate and subsequent percentages for each closed question were calculated; and open-ended themes were categorised.

In order to address these research questions, specific questions from the questionnaire were selected for further analysis, see Table 1. To answer RQ1, questions 1, 2, 5 and 6 were selected as they were all associated with the game assessment itself and how the HE students engaged with it. To answer RQ2, questions 9 and 12 were selected as they focused on how the HE students found the game assessment in relation to learning about the environment and sustainability and to answer RQ3, questions 8 and 13 were selected as they were reflective and asked students to comment on whether their behaviours had changed.

Table 1: RQs and Associated questionnaire questions

Research Question (RQ)	**Questionnaire Question(s)**
1. How do HE students engage with environmental game assessments?	Q1-What have you enjoyed most about this environmental game assessment? Q2-Would you recommend that this environmental game assessment runs again next year in this module? Why? Q5-Would you like to see more of this type of innovative/creative assessments in your other modules and in future years? Why? Q6-What did you least like about this environmental game assessment?
2. Are environmental game assessments an effective platform for learning about sustainability?	Q9-How did you find this assessment as a way of learning about sustainability? Why? Q12- Please list what you have learnt about the environment from this assessment
3. Have the environmental game assessments positively influenced the pro-environmental and sustainable behaviours of the HE students?	Q8-Has this assessment changed your own sustainability behaviour in any ways? Why? Q13-Please list what you have learnt about yourself from this assessment

2.3: Coded Analysis

To analyse the open-ended questions, post-coding analysis was applied which identified common themes or categories within the HE student responses. The first questionnaire was reviewed, line by line, and assigned numerical values to individual themes that emerged. This process was repeated for each open-ended response and formed the coding base for each subsequent questionnaire. Once completed, the recurrence of each theme in each open-ended

response was calculated before being transferred into an Excel spreadsheet where graphs were produced to visually represent the student feedback.

This process was informed by grounded theory, first; developed by Glaser and Strauss (1967), Grounded Theory is a research approach that analyses predominantly qualitative data systematically to identify repeated themes in which to answer RQs (Corbin and Strauss, 2015, p. 6). This was an appropriate method to use within this research as all the open-ended responses were personal or 'subjective' to each respondent. Grounded Theory allows the researcher to address each RQs systematically to identify patterns and trends that could then be categorised, sorted, and split into different themes that emerged as the open-ended questionnaire data as progressively analysed. In this way, the researcher is able to build a larger more qualitative picture of relationships, associations and interactions grounded out of the original open-ended empirics.

2.4: Limitations

One limitation could be the small number of participants for the 2020 cohort, as only sixteen (N=16) students completed the questionnaire This meant there was a limited amount of data that could be collected and, consequently, the results may not be fully representative for the students who completed the module.

Another limitation was the Covid-19 pandemic and the resulting national lockdowns and restrictions, which meant I could not take an active role in the data collection process. Therefore, the 2020 cohort were provided the questionnaires remotely and the completed questionnaires were received via email.

3: Results

3.1: RQ1-How do HE students engage with environmental game assessments?

When asked to comment on what they enjoyed about the assessment (Figure-1), the most common themes within the student responses were its' creativity and uniqueness, with 12 of the 16 students stating that they enjoyed the uniqueness of the assessment whilst 10 of the 16 enjoyed its' creative aspect. In addition to this, 8 of the students also commented that they enjoyed the assessment's practicality. These responses are similar to those collected in the

2017 study by Mercer et al, as 16 of the 32 students in their study also enjoyed the creative aspects of the assessment (Mercer et el 2017., p. 373).

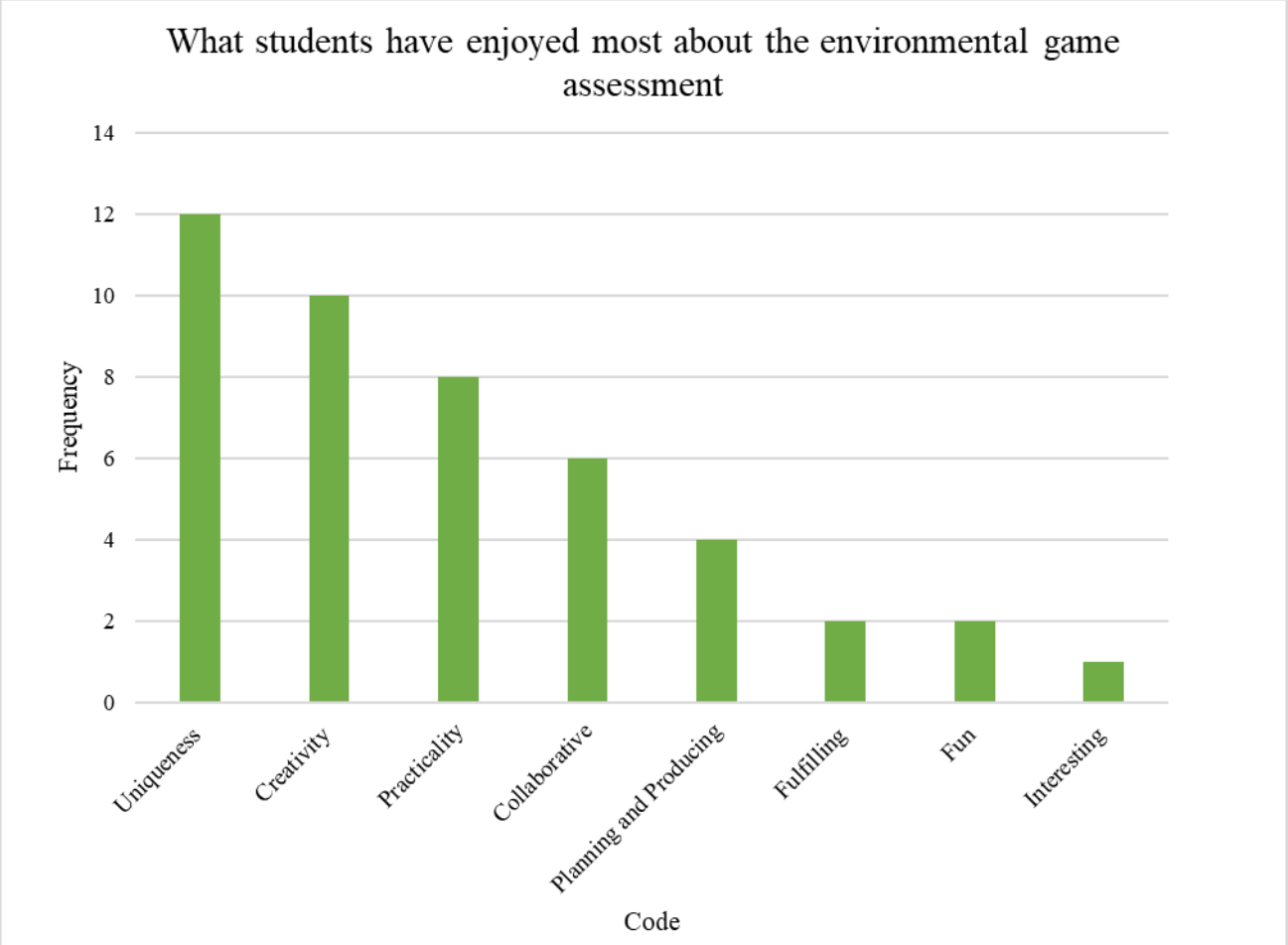

Figure-1: What the students enjoyed about the game assessment

In comparison when asked to comment on what they least enjoyed about the assessment the students' responses were varied and as a result there was no overwhelming theme identified, (Figure-2), for example 4 out of the 16 students felt the assessment was unclear, whereas 3 students felt that the assessment presented limited assessment opportunities. However, the exceptional circumstances (Covid-19) in which they completed the assessment may have contributed to their responses due to the restrictions in place at the time.

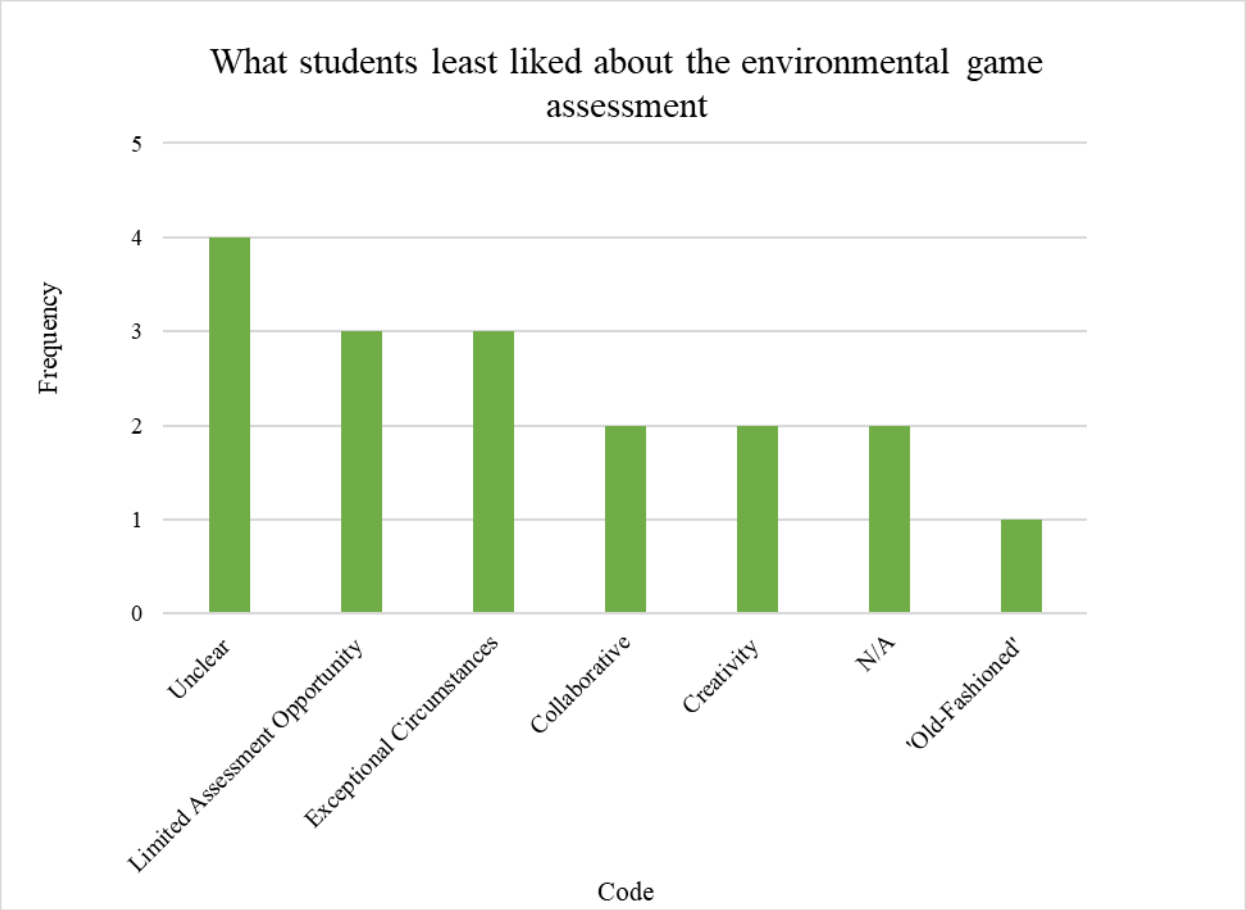

Figure-2: What students disliked about the assessment

Overall, all the students (who completed the post module survey) stated they would recommend the game assessment due to its' uniqueness and practicality, as highlighted by Figure-3. However, when comparing with the responses obtained in Mercer et al's 2017 study, it is evident that the University of Lincoln students reported more favourably as some responses reported in the study were more negative as some felt that the assessment did not relate to the course.

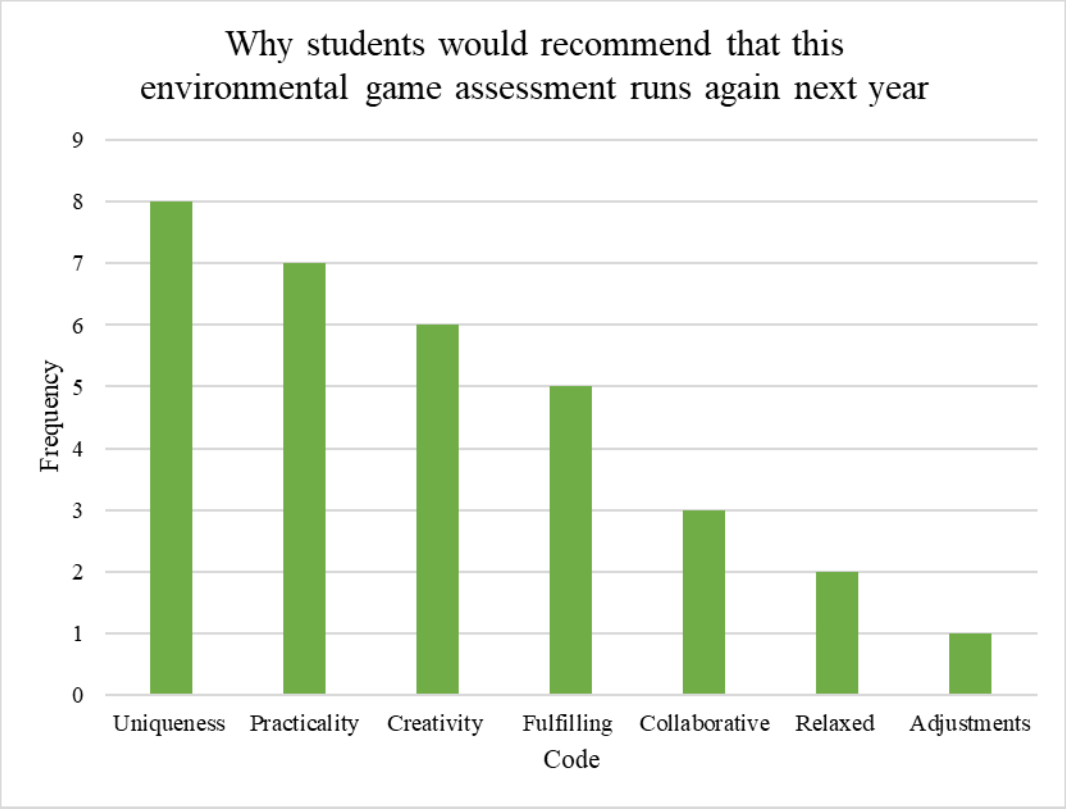

Figure-3: Reasons why students would recommend the game assessment

Additionally, when asked if they would like to see more of this type of innovative/creative assessments, 12 of the 16 respondents, stated they would like to see more of this assessment type, whilst only 2 said they would not. Figure-4 demonstrates the reasons for these responses; for example, 7 students wanted to more of this assessment style due to it being a unique way of learning, whereas 12 students found the assessment style to be both fun and engaging as well as being practical.

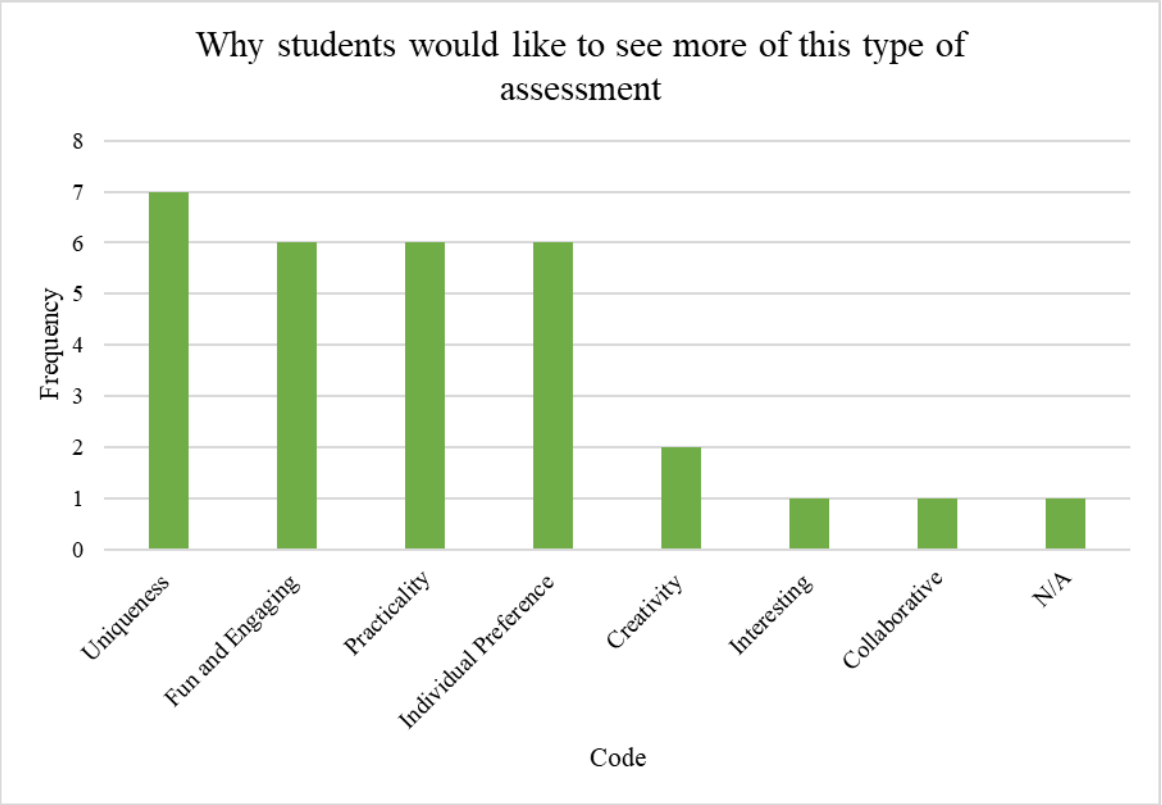

Figure-4: Reasons why students would /would not like to see more of this type of assessment

3.2: RQ2-Are environmental game assessments an effective platform for learning about sustainability?

When the students were asked how they found the assessment as a way of learning about sustainability, 12 of the 16 students reported that they found the assessment either to be 'Moderately' or 'Quite/Very Useful', as they felt that the games had increased their knowledge, whereas 4 of the students only found it to be a 'Little Useful'.

When the students were asked to state what they had learnt about the environment, a range of themes emerged and were put into appropriate categories (Figure-5). For example, some students stated that they had learnt more about the impacts of consumption, whilst others stated that their general knowledge of both positive and negative human impacts on the environment increased as a result of the game design and development process. Interestingly, some students also responded saying that as a result of the game assessment they had learnt ways to mitigate some negative impacts on the environment.

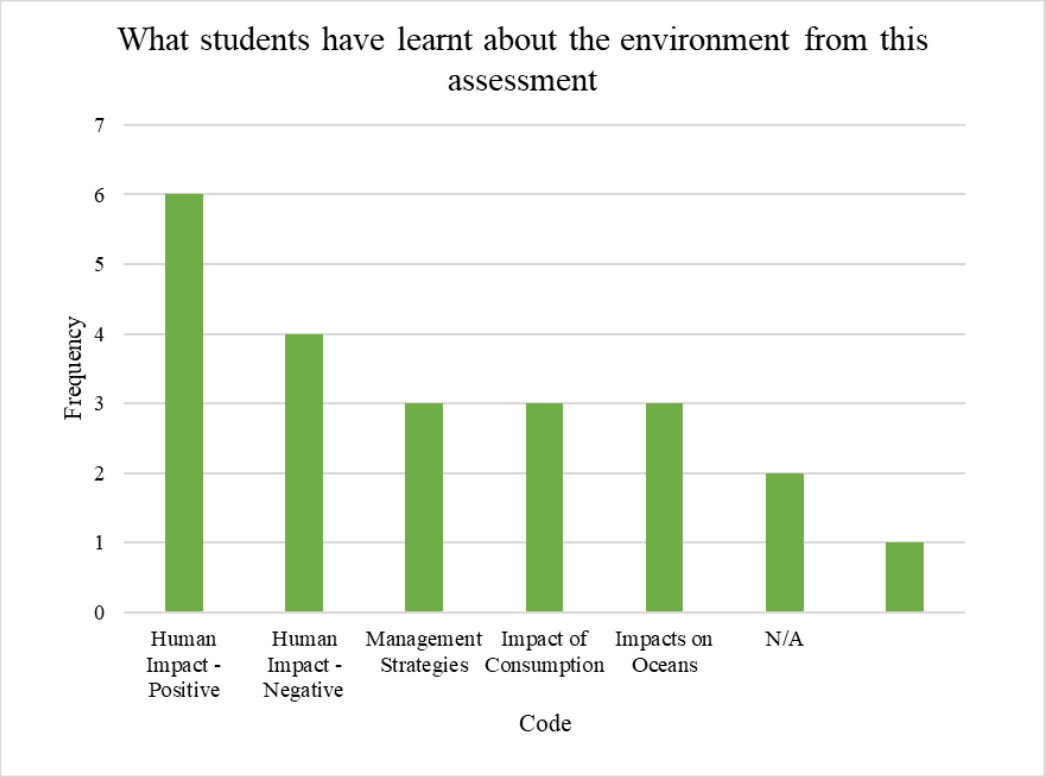

Figure-5: What the students have learnt about the environment from the assessment

Figure-5 also demonstrates that the students felt that, generally, their knowledge about the environment had improved as just under 30% reported that their environmental awareness had increased.

3.3: RQ3-Have the environmental game assessments positively influenced the pro-environmental and sustainable behaviours of the HE students?

When the students were asked if the assessment had changed their own sustainable behaviours 9 out of the 16 students said that it had either moderately or greatly improved their behaviours whilst 7 said it had only changed their behaviours a little. Despite this, Figure-6 shows that the game assessment was successful in increasing environmental behaviours and knowledge as nearly half of the students reported that they had increased environmental awareness and knowledge as a result of the game assessment. respectively. Additionally, the students reported that the game assessment had made them more environmentally proactive further highlighting the increased pro-environmental behaviours. However, 6 of the 16 students did say that they felt no change in their environmental behaviours.

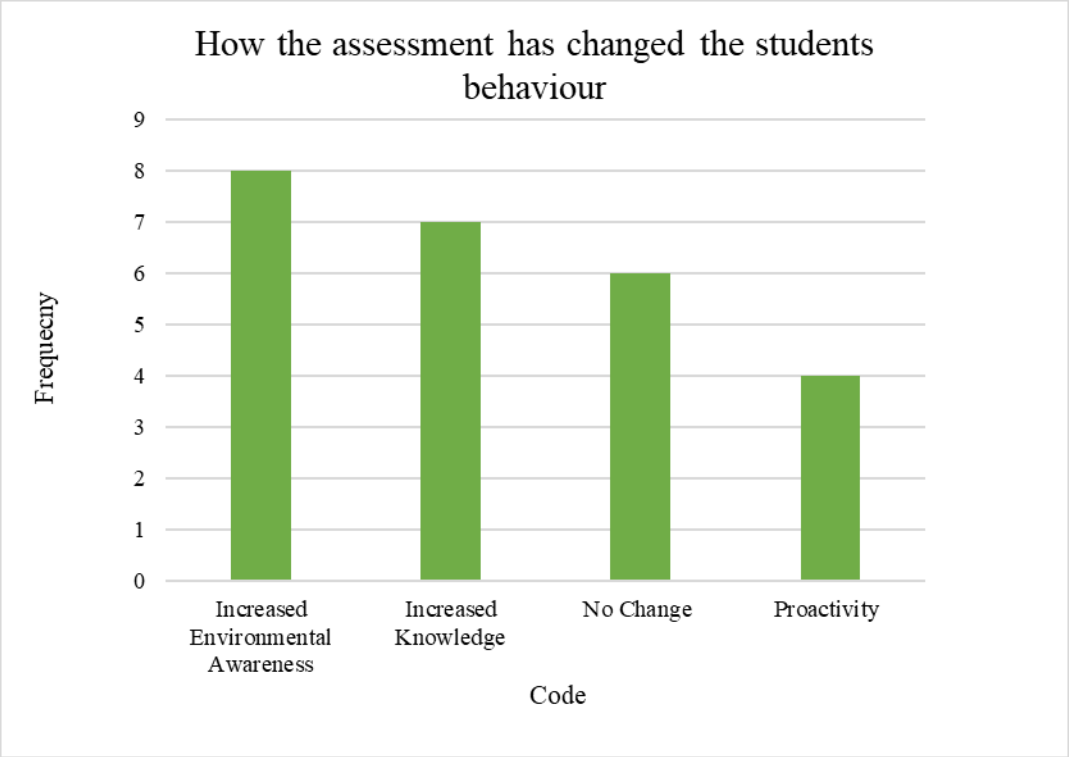

Figure-6: How the assessment has changed the students' environmental behaviours

When the students were asked to state what they had learnt about themselves from the assessment, a range of themes emerged (Figure 7). Overall, the students had a positive reflection on their experience, as they judged themselves to be more sustainable, creative, resilient and team-players. When comparing this to the 2017 study by Mercer et al, it can be argued that the students involved in their study had a less positive experience as 14 out of the 32 participants declined to comment.

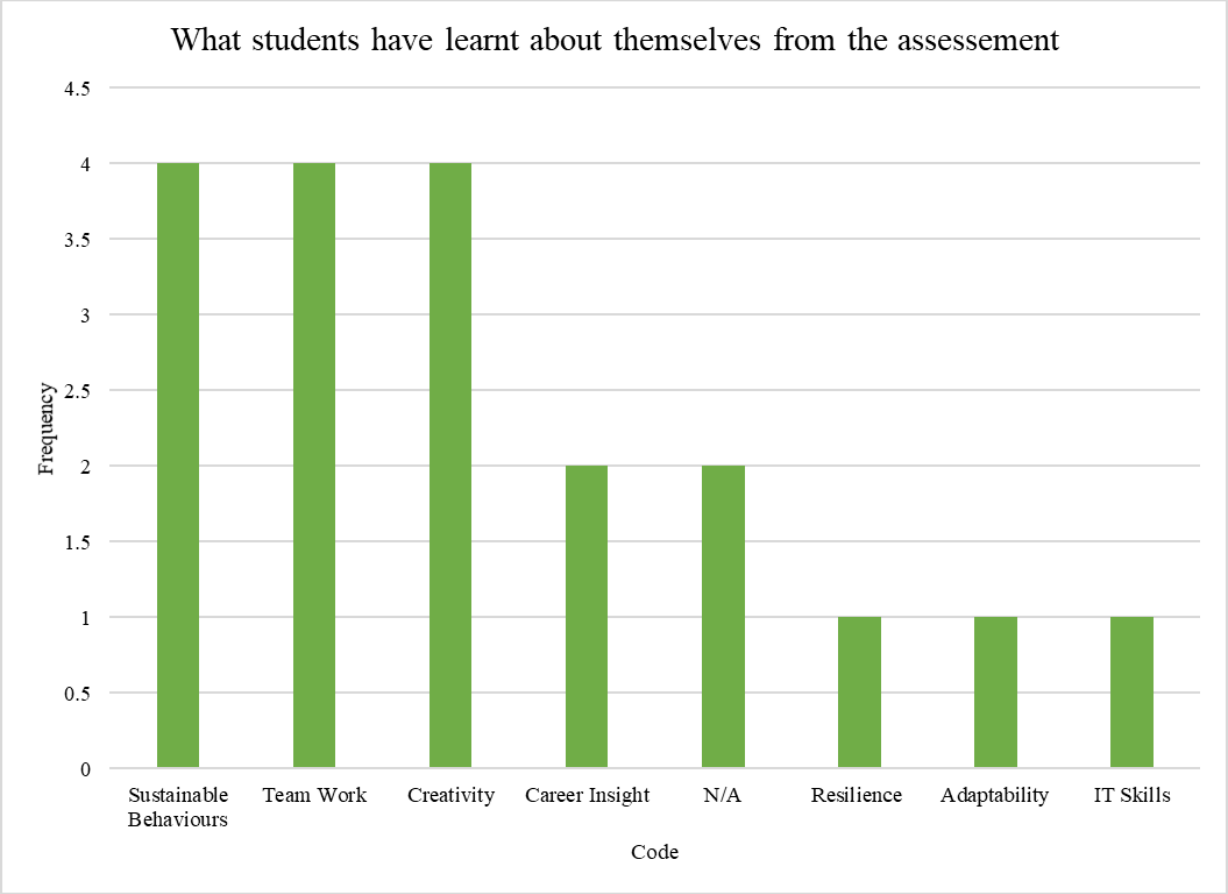

Figure-7: Shows what the students have learnt about themselves from the assessment

3.5: Summary

Overall, the results of this research show that the students enjoyed the uniqueness and creative element of the game assessment. However, the students who participated in Mercer et al's study were perceived to be more critical of the assessment compared to the 2020 students, who on average, seemed to have a more positive experience with the game assessment.

4: Discussion

4.1: RQ1-How do HE students engage with environmental game assessments?

The result of this research shows that the students generally engaged well with the environmental game assessment and recommended that this assessment style is repeated in future years. The most common theme that emerged was that the assessment was unique and

creative, with students stating, *"this assessment has been refreshing", "it has introduced an alternative type of assessment"* and *"it allowed us to learn through more practical and creative thinking"*. These responses highlight how the unique form of assessment was positively received by the students. Similarly, many found the assessment to be a *"fun and engaging way to apply relevant knowledge"*. The game assessment also allowed them to *"apply skills learnt over the course in a real-world example"*, further demonstrating that the practical element of the assessment allowed the students to contextualise and address real-life issues in a way that they could fully engage with.

This outcome agrees with the findings of previous studies and supports the theory that Game Based Learning is an effective method of engaging students by providing alternative opportunities to explore environmental issues and sustainability, in a way that has not been previously available to them (Liarakou et al., 2012; Madani et al., 2017). As the students chose their own environmental issue to base their game upon, they had complete control of their own learning; for example, one group designed a game around the impact of Palm Oil on the environment, another chose a game to highlight the impacts of food consumption, whilst another designed a game to educate students on recycling and waste; further increasing their engagement. This was reflected by the overwhelming number of students who cited that they particularly enjoyed the creative element and freedom the assessment provided. This further demonstrates that they engaged with the game assessment and that their overall experience was benefitted by thinking creatively. This is supported by Sandri (2013) who found that creativity is an important aspect of ESD as it encourages innovation alongside problem solving which is vital in promoting sustainable and pro-environmental behaviours. However, Sandri (2013) acknowledged that there is still a lack of creativity within HE, which can be supported by this research as many of the students commented on the uniqueness of the assessment indicating that they had limited experience of this style of learning.

Furthermore, student engagement is an important aspect to focus on in any subject area; in terms of improving sustainable and pro-environmental behaviours, if students are more invested and more involved with learning about a specific environmental issue, they are more likely to reduce their own negative environmental behaviours and promote more pro-environmental and sustainable behaviours (Dieleman and Huisingh, 2006).

Despite the overwhelming positive response, some students, did report some negative feedback; some students found that the assessment *"wasn't very challenging"* and that they

preferred more essay-based assessments as they could *"go into greater detail that tests your knowledge more"*. This highlights that it is important to consider different learning styles and preferences when trying to increase student engagement in unique and novel ways; to overcome this there the assessment also includes an essay-based component which gives students the opportunity to go into greater detail regarding how their games encourage pro-environmental behaviours. Additionally, some students found that the assessment would be better if it moved towards more digital-based games. This is an important consideration for future research due to the everyday use of mobile phones and computers. This concept has been explored by Janakiraman et al (2021) who found that digital games are more effective in promoting sustainable and pro-environmental behaviours compared to traditional methods; whilst Troussas et al (2020) found that the use of mobile-based games within HE had a positive impact on students and enabled them to further expand their knowledge, which further shows that GBL increases student engagement.

4.2: RQ2-Are environmental game assessments an effective platform for learning about sustainability?

From the questionnaire responses the most commonly selected answer was that the game assessment was 'Moderately Useful' in learning about sustainability. This suggests that the students did gain new knowledge from undertaking the game assessment and that their environmental knowledge and awareness increased as a result.

This outcome is reflected in current literature. Many academics have found that game and project-based learning enable HE students to educate others whilst further educating themselves alongside promoting their own sustainable and pro-environmental behaviours (Reisz, 2020). One of the main conclusions of the game assessment was that the students realised that *"little everyday things can help us have less impact on the environment"* and that *"environmental issues can be taught to anyone who is interested".* These student responses suggest that the game assessment was effective in learning about sustainability as their own behaviours and attitudes changed for the better. These findings are supported by Janakiraman et al (2018) who found that games are a good tool to use within ESD as they can cause attitudes and behaviours to change, promoting more sustainable and pro-environmental behaviours. The authors also found that using real-life examples further benefitted

behavioural changes as the players could visualise real-life consequences, which mirrors the student responses in RQ1.

When comparing the results of this study with those obtained in the research by Merccer et al 2017, a higher percentage of the students in this study found the game assessment to be 'Quite/Very Useful' in learning about sustainability, whereas the students surveyed in Mercer et al's 2017 study were more critical. This is further emphasised when analysing the student responses; some felt that they had learnt nothing new and that *"most of the assessment was applying prior knowledge",* whereas other students found that the game assessment had expanded their *"knowledge and conceptions of sustainability"*, showing the discrepancies amongst the student responses. However, in Mercer et al's study (2017) the students had to design a game suitable for primary school aged children meaning the students in their study were restricted in the games they could produce. This suggests that for game design to be effective in promoting sustainable behaviours in HE students, the target audience should be closer to their own ages as it will allow them to create more complex and challenging scenarios, expanding their own knowledge in the process.

4.3: RQ3-Have the environmental game assessments positively influenced the pro-environmental and sustainable behaviours of the HE students?

The results of this study show, the game assessment did impact positively on the HE students own pro-environmental and sustainable behaviours, as many of the students reported that the game assessment had increased their knowledge, awareness, and pro-environmental activity. Many of the students in Mercer et al's study stated they had volunteered at a Sustainability Hub; whilst many of the students, in this study, reported they had become more conscious about their own impact on the environment, stimulating them to become more environmentally aware. For example, one student stated that *"no matter how much you may know about sustainability there is always advances and more to learn",* suggesting that their own knowledge increased as a direct result of the assessment; whereas another student acknowledged that *"sustainability is a manageable task in daily life"* indicating that their perception of sustainability and pro-environmental behaviours had changed to enable them to incorporate small changes in their everyday life, providing further evidence that the game assessment had a direct, positive impact on the students' pro-environmental and sustainable behaviours.

These results illustrate that the environmental game assessment positively influenced the students to adopt pro-environmental and sustainable behaviours. This agrees with Hsieh (2020) who stated that sustainability and pro-environmental behaviours are positively influenced through environmental games as students are able to become invested in learning about environmental issues and ways in which these issues can be overcome. As a result of this, the students own attitudes and behaviours changed as they were able to form an 'emotional attachment' to their chosen issue and would have wanted to lessen their own impact on the environment (Dieleman and Huisingh, 2006, 840).

However, these results are purely based on the students self-reporting that their own pro-environmental and sustainable behaviours had been positively influenced by the game assessment and, as a result, the extent of change may have been exaggerated. This theory has been explored in the study by Moore and Rutherfurd (2020), who assessed the reliability of self-reporting data. In the study the authors found that 60% of self-reported data was unreliable due to the participants wanting to be perceived as demonstrating pro-environmental behaviours. This could be applied to the results of this research, as although the questionnaires were completed anonymously, the students may have wanted to be seen as already displaying or have greatly improved pro-environmental and sustainable behaviours.

Many of the students commented that they felt they were already sustainable and as a result may not have acknowledged that the assessment may have had an impact. If the students already perceived themselves to be sustainable, they may not have adopted any new behaviours that could have been learnt and attributed to the game assessment, which in the long term could have a negative impact on their sustainable and pro-environmental behaviours, which is reflected in the study by Vicente-Molina et al (2013).

5: Conclusion -

This study has evaluated HE student responses pertaining to the effectiveness of game design and development in learning about and promoting sustainable and pro-environmental behaviours. Overall, this study demonstrates, that to some extent, game design and development are effective tools to engage HE students with ESD, whilst promoting sustainable and pro-environmental behaviours. This is particularly evident within RQ1 as all students engaged well with the game assessment, with many students acknowledging that

their own sustainable and pro-environmental behaviours changed as a result. This outcome has many implications for the future of ESD within HE, as it highlights that students attain higher engagement levels when they are in control of their own learning in a creative environment. This shows that the future of HE should include, alongside traditional academia, more innovative, creative and independent learning to allow students the opportunity to explore and develop their own critical thinking and problem-solving skills.

However, this study cannot fully state that environmental game design and development will alter all HE students' sustainable and pro-environmental behaviours. as this study has highlighted that the HE student responses were subjective as each questionnaire answer was personal to each student. It also highlighted that perhaps some of the HE students were biased as they already believed themselves to exhibit sustainable and pro-environmental behaviours so felt that the environmental game design and development assessment did little to increase and enhance their behaviours, further showing the inconclusiveness of this research.

In order to improve this study for future research one recommendation would be to obtain baseline pro-environmental and sustainable behaviours of the HE students as these could be used to compare and contrast changes in their behaviours following the integration of game design and development within their university degree courses. Similarly, to acquire more comprehensive data regarding the effectiveness of game design and development in promoting sustainable and pro-environmental behaviours, steps should be taken to encourage more students to take part in the research. Further to this, in order to truly measure the effectiveness of game design and development in promoting sustainable and pro-environmental behaviours, it would be beneficial to future research if other subject areas beyond STEM subjects were included as they could offer more representation of the entire HE student body. Finally, as a consequence of the Covid-19 pandemic and the subsequent shift to online learning, future research could focus on the effectiveness of digital games in promoting sustainable and pro-environmental behaviours.

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