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For People and Planet: A Pilot Study of an Educational Mobile Game on the Sustainable Development Goals

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Abstract: *For People and Planet: An SDG Adventure* refers to a freely available Android-based narrative adventure game and teacher resource pack that helps learners see the United Nations Sustainable Development Goals (SDGs) in their day-to-day lives. In this paper, we describe the results of a pilot study of the game with 29 middle school Science students from the Philippines. The purpose of the study was to determine whether the students gained new knowledge from the game and how they characterized the game experience. The study found that learning was uneven with most students achieving quiz scores of 65% or higher but with one cohort averaging only 40%. Despite the unevenness of the knowledge assessment, students agreed that the game made them feel competent, gave them a sense of flow, and was immersive, albeit not very challenging. Opportunities for improvement include the creation of versions of the game for other platforms, deployment of the game in other subject areas, and further editing of the teacher resource pack.

Keywords: Sustainable Development Goals, Mobile Game, STEM education, Philippines, Pilot Study

1. Introduction

In 2015, United Nation Member States adopted the seventeen (17) Sustainable Development Goals (SDGs) that aimed to end extreme poverty, improve everyone's quality of life, and to protect the natural environment from degradation by 2030 (UN, 2016). To fulfill these goals, all sectors of society had and continue to have a role to play. Schools were responsible not just for educating students about these SDGs but also for guiding their formation towards the practice of sustainability in their everyday lives (Filho, et al., 2019, Nousheen, Zai, Waseem, & Khan, 2020).

Teaching about the seventeen SDGs can be daunting as it requires adjustments in existing curricula and teaching methods (Williamo et al, 2018, Hensley, 2020). Furthermore, traditional methods of teaching tend to have low engagement among young learners in particular (Prensky, 2006). One innovative approach that has been shown to be an efficient and engaging method of explaining environment and sustainability related concepts is game-based learning (Katsakiali and Mustafee, 2012, Bevilacqua, et al., 2015).

For People and Planet: An SDG Adventure refers to an Android-based narrative adventure game that attempts to address some of these needs. Contextualized in the Philippines, *For People and Planet* addresses Filipino learners specifically and attempts to help them see the SDGs in their day-to-day lives. This paper describes a pilot study conducted with this game and attempts to describe both the pilot study design process and the pilot study's outcomes. We wanted to know if this innovative approach delivered was indeed an effective and engaging method of teaching and learning, i.e. whether they learned something from playing the game and whether they enjoyed the learning experience. The specific research questions we attempted to answer were:

- To what extent was the game able to fulfill the learning goals of the lessons?
- How did the students characterize the game experience?

2. For People and Planet: An SDG Adventure

As mentioned in the introduction, *For People and Planet: An SDG Adventure* is a narrative-based adventure game for the Android phone or tablet that helps learners see the SDGs in their day-to-day lives. Its design is described in detail in Rodrigo, Diy, and colleagues (2021). The game is intended as supplementary material to middle school lessons on SDGs. The design of *For People and Planet* echoes the themes of contextualization and activity-based tasks. All activities are grounded in the Philippine context by selecting situations that are typical of the Philippines and are linked to the Philippine basic education curriculum's Most Essential Learning Competencies (MELCS). The game is accompanied by a teacher resource pack that contains sample lesson plans, sample assessments, slide decks, and supplementary materials. This teacher resource pack is discussed in detail in (Rodrigo, Torres, et. al, 2021).

In the game, players assume the role of a middle school student in a rural community in the Philippines and embark on five (5) stories that can be played in any order. Each player is shown how the community encourages sustainability and maintains their environment through errands that the player accomplishes. Each story covers an aspect of life and ties it to one or more SDGs. In *What's For Lunch?*, the player is asked to buy food for the family's lunch (See Figure 1). In *Flood Fighters*, the player accompanies the grandmother and learns about disaster risk reduction and disaster risk management, both at the community and at the household levels. In *A Walk in the Park*, the player goes to a neighboring town with friends to learn about clean energy and wastewater treatment. In *Work, Work*, the player visits the community enterprise where the grandmother works. In *Learning is for Everyone*, after attending a theater workshop in school, the player befriends a student with low vision.

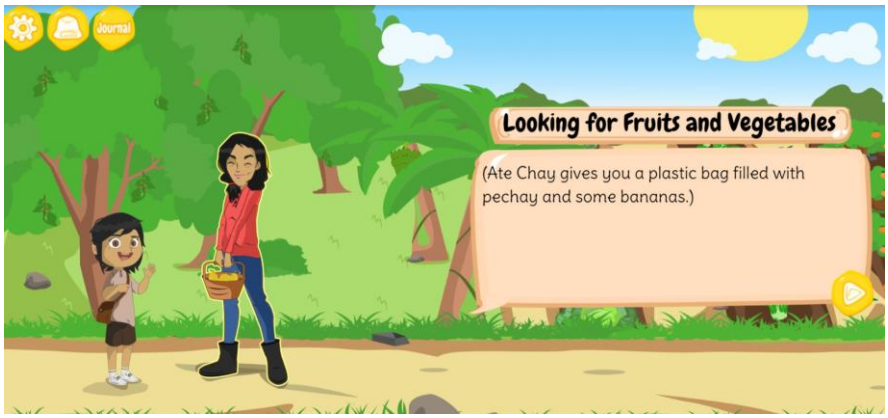

Figure 1. Ate Chay gives the player a basket of fruits and vegetables after the player completes the quest.

Within each story are mini-games that players have to accomplish in order to complete game quests. Mini-games were designed as simple, fun ways to provide more interaction and to break the monotony of reading character dialog and educational text. Some mini-games also provide an alternative way to present certain lessons. For example, in the ocean cleanup minigame, the player must collect as much trash as possible within the allotted time (See Figure 2) while in the Go-Bag mini-game, players must collect items such as flashlights and radios, needed for a go bag.

3. Pilot Study

This section describes the design and implementation of the pilot study including the participants, the lesson plan preparation, and the assessment design. The protocols for the pilot study were submitted to the University Research Ethics Office. The protocols were deemed to be exempt from review because this was research that was "conducted in established or commonly accepted educational settings, involving normal educational practices, such as … research on the effectiveness of … instructional techniques, curricula, or classroom management methods." (R. Cruz, Personal Communications). Data from all respondents was anonymized for this report.

Figure 2. Ocean Cleanup Mini-game.

3.1 Description of Teachers and Students

The pilot study was conducted in a private, all-boys school located in Metro Manila, Philippines. A total of four teachers (all female) and the Science subject area coordinator (male) participated in the study, now co-authors of this paper. On average, they had 8 years of experience teaching science at the grade school level. By the time they participated in this study, they had been teaching online for around 16 months because of the COVID-19 pandemic. They had previously undergone training related to teaching with technology. Training topics included G Suite for Education, Google Workspace, Robotics (Lego Education WeDo 2.0 and Lego Mindstorms EV3) and various apps for online classes.

A total of 29 students from grades 3 to 6 participated in the study, ranging in age from 8 to 11 years old. Of these 29, only 26 completed the pilot study.

As this was a pilot study as opposed to a full implementation, the teachers recruited student participants from among their classes based on the students' willingness to participate in after-school sessions, ownership or access to an Android device, and permission from their parents or guardians to join the study. Their participation was voluntary and had no impact on their final grades. Both the students and their parents gave written assent and consent to participate respectively. Furthermore, the study protocol was reviewed and approved by the University Research Ethics Office.

3.2 Lesson Plan Preparation

To prepare for the pilot study, the teacher-volunteers and the Science subject area coordinator met with the game developers for familiarization with the game and to discuss the purpose of the study. Since the subject area coordinator had the most comprehensive knowledge of the topics within the overall Science curriculum, he was the one who suggested which of the stories within the games would best fit the curriculum of each grade level.

For Grade 3, for example, the story "What's for Lunch?" was chosen because it is aligned with the third quarter lesson on food, water, and balanced diets. For Grade 6, the story "Flood Fighters" was chosen because it was aligned with the second quarter lesson on disaster preparedness, risk management, typhoons, and public storm signals.

After the meeting, the teachers downloaded and played the game on their devices in order to assess its age-appropriateness and to also foresee possible sources of difficulties on the students' end. The teachers also studied the resource pack (Rodrigo, Torres, et al, 2021). The teachers used the resource pack's references, sample assessment tools and other helpful information as they crafted their lesson plans. Teachers adopted most of the learning objectives articulated in the resource pack, adding to them as needed, e.g. the Grade 3 teacher added learning objectives regarding food production while the Grade 6 teacher added affective components that best fit the lesson as well as the game.

Each teacher created a lesson that blended with the curriculum, depending on the students' prior knowledge. In the case of Grade 6, the students had already taken lessons on typhoons and disaster preparedness prior to the use of the game. The teacher therefore created a lesson that leveraged on this knowledge and used an inquiry-based approach to teaching science called the Inquiry-Concept

Formation-Information Approach or I-C-I. This method helps students develop higher-order cognitive skills by going beyond the texts and look for answers to problems through well planned discussions and investigations.

During the Inquiry Stage, the students were asked to play the story "Flood Fighters" for 30 minutes. Afterwards, the teacher asked several questions which scaffolded Concept Formation, asking questions such as *What was the first activity that you were asked to do?* (Answer: Help in the relief efforts of the barangay) or *What did you do as part of the relief effort?* (Answer: Identify appropriate clothes for donation, classify relief goods).

The students answered based on their experiences within the game and the answers served as an anchor for the Information Stage in which key points of the lessons were restated. For example, teachers could reiterate that preparation for disaster is key and that before a disaster strikes, we should make sure we have the supplies and equipment in case there is no electricity, no communication, or no means to travel to buy what we need.

3.3 Assessments

At the end of the lesson, students were asked to take two types of assessments: a knowledge assessment and selected statements from the Game Experience Questionnaire (GEQ; IJsselsteijn, de Kort, & Peols, 2013). All the knowledge assessments included 5 questions that tested the students' comprehension of the content of the game

The GEQ questionnaire on the other hand, was an instrument that measured the players' experience. The complete GEQ consists of 33 statements that measured seven (7) components of a player's experience: competence, sensory and imaginative immersion, flow, tension/annoyance, challenge, negative affect, and positive affect. From these 33, we selected 23 statements, making sure that all seven components were represented. Participants indicated their level of agreement (strongly disagree to strongly agree) with each of these statements.

At the end of the GEQ, the research team also included open ended questions asking what students liked most and least about the game, what about the game made learning the topic fun, interesting, or easy to learn, and what about the game made the topic boring or difficult to learn.

4. Results

In this section, we summarize the results of the pilot study into three sections: results of the knowledge assessments, results of the GEQ, and qualitative responses and observations.

Average student performance varied from grade level to grade level. Grade 5 students averaged the highest at 92% while the Grade 4 students did the poorest at 40%. The Grade 3 cohort scored 80% while the Grade 6 cohort scored 65%. The results imply that the game was a learning experience for most students, but it perhaps did not appeal to others. Why exactly the Grade 4 cohort scored so badly is unclear. We speculate that the students did not take the assessment seriously as it had no bearing on their final grades.

Despite the uneven knowledge assessment results, the GEQ results showed that the students regarded the game well. The scores for competence, sensory and imaginative immersion, flow, and positive affect were between "Agree" and "Strongly Agree." The game did not elicit tension and annoyance nor negative affect. The challenge score, though, leaned towards "Disagree" which implied that the game was not very challenging.

The qualitative responses of the students and the teachers' observations corroborated the GEQ results. One teacher noted that students arrived early during the game orientation session and expressed excitement to play the game. Most were able to install the game without difficulty but one student did not have access to an Android device. The game development team therefore prepared a Windows version of the game for him. While he was able to download and install the game, doing so required assistance from the development team.

One theme that emerged was that the game made learning fun. Students liked learning about how to help people and the environment. They also liked learning about the importance of work-life balance. One student said he liked how the game "has a real world relevance and … is fun."

Students repeatedly said that they liked the mini-games in particular. The mini-games were interactive and made learning easy. Important lessons such as what to do in the event of a disaster were made interesting and fun through these activities. Teachers appreciated that the mini-games were set in the Philippine context, which made them relatable.

The mini-games also helped students appreciate some of the processes that they were not completely aware existed. For example, students are not aware of food production. The Grade 3 teacher said that students "think that food is always ready since they can find [it] inside their refrigerator." The mini-games in "What's for Lunch" help them that before the food becomes available in groceries and markets, all of the ingredients needed to make our healthy meals were harvested by farmers and fisherfolk. The game helps them value the hard work of farmers and fisherfolk which may make them become more responsible consumers.

Teachers observed that there was a good match between student learning preferences and the game format. One teacher said that students, "do not want the usual pen and paper activity. They want to be engaged and to explore. They easily get bored and they always look forward to do something new and unusual." The game therefore fit this preference.

Students also appreciated the game was intuitive. One of the teachers observed that the students needed a minimum of coaching, a few clarifications at most, in order to navigate their way through the game. The tasks in the game were clearly defined and achievable because instructions were clear. "The directions were easy to follow, and the flow of the game was easy to understand," one student said.
Students were eager to participate in discussions that followed gameplay. Teachers noted that it was easy to elicit responses from the students and that students shared their thoughts freely.
Some students did say that some of the text tended to be quite long. One student said, "Although I know that it is important and part of the learning process, I find the long sentences in the introduction a bit dull." Other students said they wanted more challenge and that the design was "a bit too cartoonish."

5. Conclusions and Recommendations

We embarked on this pilot study to answer to answer two main questions: To what extent was the game able to fulfill the learning goals of the lessons? How did the students characterize the game experience?

We found that the game succeeded in being a learning experience for most students, though one cohort was less successful. If the game is less effective for some learners, finding out why is something that could be explored in follow up studies, or during actually in-class deployment.

We also found that, in general, the students enjoyed the game. The characteristics that contributed to the positive game experience included the high level of interactivity of the mini-games, the valuable lessons that the game contained, and general ease of use.

The pilot test also helped the team identify some ways forward. From a technical perspective, the game development team needs to make an iOS version of the game available as well as a more easily installable Windows version.

In terms of potential for use, teachers saw how the game can be an effective way to introduce students to the SDGs, not just within Science classes but also in other subjects. For example, the games about social responsibility, food supply, sustainable cities (urban/rural communities) could be used as part of their Social Studies lessons. Some of the scenarios presented could be the springboard for essays and discourse in English or Mother Tongue. The teacher's responsibility is to make sure that the planned activities are age-appropriate.

In order to maximize this potential, teachers will need to familiarize themselves with the game in order to find alignment between the game's contents and their lessons. The resource pack was very helpful in this regard, but teachers observe that the resource materials are quite text-heavy and need to be trimmed.

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References

Bevilacqua, M., Ciarapica, F.E., Mazzuto, G., Paciarotti, C. (2015). Cook & Teach: Learning by playing. Journal of *Cleaner Production. 106*: 259-271.

Filho, W. L., Shiel, C., Paço, A., Mifsud, M., Ávila, L. V., Brandli, L. L., Molthan-Hill, P, Pace, P., Azeiteiro, U. M., Vargas, V. R., & Caeiro, S. (2019). Sustainable Development Goals and sustainability teaching at universities: Falling behind or getting ahead of the pack?. *Journal of Cleaner Production*, *232*, 285-294.

Hensley, N. (2020). Educating for sustainable development: Cultivating creativity through mindfulness. *Journal of Cleaner Production*. 243.

IJsselsteijn, W. A., De Kort, Y. A., & Poels, K. (2013). The game experience questionnaire. Technische Universiteit Eindhoven. Available online: https://research.tue.nl/en/publications/the-game-experience-questionnaire

Katsaliaki, K., and Mustafee, N. (2012). A survey of serious games on sustainable development. In: *Proceedings of The 2012 Winter Simulation Conference*, 300–312. Edited by C.Laroque et al., Piscataway, New Jersey: IEEE.

National Research Council. (2000). *Inquiry and the National Science Education Standards : A Guide for Teaching and Learning*. National Academies Press.

Nousheen, A., Zai, S. A. Y., Waseem, M., & Khan, S. A. (2020). Education for sustainable development (ESD): Effects of sustainability education on pre-service teachers' attitude towards sustainable development (SD). *Journal of Cleaner Production*, *250*, 119537.

Prensky, M. (2006). Don't bother me, Mom, I'm learning! How computer and video games are preparing your kids for 21st century success and how you can help. St. Paul: Paragon House.

Rodrigo, M. M. T., Diy, W. D., Favis, A. M. T., Amante, F. U., Castro, J. C. M., Herras, I. Y., Mallari, J. C. F., Mora, K. A., Torres, J. M. R., Cuyegkeng, M. A. C. (2021). A RECIPE for teaching the sustainable development goals. In M. M. T. Rodrigo, S. Iyer, & A. Mitrovic (Eds.), *Proceedings of the 29th International Conference on Computers in Education* (pp. 451-465). Asia-Pacific Society for Computers in Education.

Rodrigo, M. M. T., Torres, J. M. R., Castro, J. C. M., Favis, A. M. T., Herras, I. Y., Amante, F. U., Jimenez, H., Mallari, J. C. F., Mora, K, A., Diy, W. D., Lim, J. T. T. & Cuyegkeng, M. A. C. (2021). For People and Planet: Teachers' Evaluation of an Educational Mobile Game and Resource Pack. In M. M. T. Rodrigo, S. Iyer, & A. Mitrovic (Eds.), *Proceedings of the 29th International Conference on Computers in Education* (pp. 657-666). Asia-Pacific Society for Computers in Education.

UN. (2016). *The Sustainable Development Goals Report*. NY: United Nations. Retrieved from https://unstats.un.org/sdgs/report/2016/The%20Sustainable%20Development%20Goals%20Report%202016.pdf.

Willamo, R., Helenius, L., Holmström, C., Haapanen, L., Sandström, V., Huotari, E., Kaarre, E., Värre, U., Nuotiomäki, A., Happonen, J., Kolehmainen, L. (2018). Learning how to understand complexity and deal with sustainability challenges – A framework for a comprehensive approach and its application in university education. *Ecological Modelling. 370*: 1-13.