Factors Affecting Sustainable Use of Minecraft-based Lessons

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Abstract: This paper examines the factors that affect the sustainable use of Minecraft-based lesson plans. We focus specifically on teachers who received training on using What-If Hypothetical Implementations in Minecraft (WHIMC), a set of Minecraft worlds designed to teach astronomy, geosciences, and ecology. We commissioned a group of teachers to develop lesson plans using at least one of the WHIMC worlds and pilot their implementation in their classes. Another group of teachers received training on developing learning modules with WHIMC but had the freedom to choose when and how to implement their lesson plans during the school year. The teachers cited logistical impediments, scheduling impediments, lack of technical resources, lack of curricular alignment, changes to teaching modalities, limited time for practice, and anxieties about classroom management as barriers to sustainable use of WHIMC. They suggested the training of additional teachers to create a community of practice whose members can collaborate and support each other's use of WHIMC for STEM education.

Keywords: WHIMC, Philippines, Game-based Learning

1. Context

In 2020, the Ateneo de Manila University (ADMU) and the University of Illinois Urbana-Champaign (UIUC) entered into a partnership in which UIUC allowed ADMU to use its What-If Hypothetical Implementations in Minecraft (WHIMC; https://whimcproject.web.illinois.edu/) in schools in the Philippines. WHIMC is a set of computer simulations built in Minecraft Java Edition to engage students in "what if" questions such as "What if Earth had no moon?" or "What if Earth had a slightly colder sun?" WHIMC immerses students in these alternate versions of Earth, giving them opportunities to see how the planet's geography and life forms would differ under these circumstances. It enables students to use science tools to collect data about these alternate Earths and record their observations.

The UIUC team successfully used WHIMC in summer school programs (Lane, et al., 2022). It also recently partnered with several planetariums to include WHIMC installations among the planetariums' exhibits. Furthermore, UIUC has used the data collected from their WHIMC deployments to study learner-related phenomena such as the structure and skill level of learner scientific observations (Hum, et al., 2022) and STEM interest behaviors (Gadbury & Lane, 2022), among others.

Leveraging on UIUC's success, the goal of the ADMU team was to determine whether WHIMC could cultivate Filipino learners' interest in STEM. ADMU researchers were motivated by the need to improve Science, Technology, Engineering and Mathematics (STEM) achievement in the Philippines. The PISA National Report on the Philippines (Philippines Department of Education, 2019) said that, compared to the OECD average of 489 in math and 489 in Science, Filipino students scored a low 353 and 357 respectively. Only 1 out of 5 attained the minimum proficiency level in math. These results are corroborated by students' performance in the National Achievement Test, where only 25%

demonstrated mastery levels in math and only 5% of test takers demonstrated mastery levels in science.

Through a 2021 grant from the Philippines' Department of Science and Technology, the ADMU purchased 212 Minecraft Java Edition licenses and rented a server that allowed it to mirror the UIUC WHIMC site. The ADMU team then worked with teachers to help them gain familiarity with WHIMC and develop lesson plans that integrated WHIMC in science, math, and even English classes. The ADMU team also provided the teachers with technical support during actual conduct of these lessons.

Since then, the ADMU team has trained 23 teachers for WHIMC Java Edition and 24 teachers for WHIMC Education Edition. In the ADMU WHIMC Java Edition server, over 304 students were able to explore it. Furthermore, it developed a Minecraft Education Edition version of some of the worlds (see teachers' guide through bit.ly/WHIMCEETeachersGuide). This version has been used by 78 students and 5 teachers in 2 Philippine schools. The ADMU team also used the data from its deployments to study the effects of WHIMC on student STEM interest (Tablatin, Casano, & Rodrigo, 2023), the relationship between STEM interest and student affective states such as frustration and boredom (Esclamado, Rodrigo, & Casano, 2022), and to compare the quality of Philippine and US student observations (Casano & Rodrigo, 2022).

Despite these successes, continued use of WHIMC is not guaranteed. Indeed, now that the DOST grant has ended, the overarching question we pose in this paper is one of sustainability. Will teachers continue using WHIMC as the ADMU project team starts removing the scaffolds? In this paper, we attempt to examine what factors contribute or hinder the sustainability of WHIMC use in Philippine classrooms.

2. Sustainability of Educational Technology Initiatives

In the context of educational technology initiatives such as WHIMC, sustainability is defined as persistent and ongoing change of the educational culture (Neiderhauser, et al., 2018). Sustainability is a process that unfold when support systems are established and the community in which the initiative takes place maintains the initiative over time. When an initiative is sustained, the innovation or intervention becomes richer and more sophisticated as it evolves. Initiatives factor in changes in context. Increased knowledge of and comfort with the innovation prompts stakeholders to maximize the innovation's affordances.

These characteristics of sustainability are evident in many Minecraft applications. The work of Lincenberg and Eynon (2021) discusses how educators use Minecraft to transform classrooms into social spaces where teachers and students could visit or challenge each other, spaces where students could respond to the curriculum in their own ways, e.g. by solving problems that their teachers gave or that they defined themselves. A review by Baek, Min, and Yun (2020) shows how Minecraft has been successfully integrated in science, math, social science, and language subjects, and has been shown to increase creativity, improve technology skills, increase collaborative skills, and encourage communication.

There are, however, many factors that hinder the sustainability of educational technology initiatives. Ertmer (1999) classifies these barriers into two: first-order barriers are extrinsic to teachers. These include lack of equipment, time, training, or support. Second-order barriers are intrinsic to teachers. These include teachers' underlying perceptions about how teaching and learning should take place. First-order barriers are often cited particularly in developing world contexts. In Tanzania, for example, barriers included a lack of basic infrastructure and a lack of motivation and support from school management are impediments (Kafyulilo, Fisser, & Voogt, 2016). In the Philippines, the cost of Internet access, the lack of curricular alignment, and insufficient teacher professional development make it difficult for schools, teachers, and students to incorporate technology in their classes (Rodrigo, 2021).

Second-order barriers have been discussed in the context of Minecraft-based lessons. Thinking of ways to incorporate Minecraft in lessons necessitates familiarity with technology in general and Minecraft in particular. This creates work that is over and above

regular teaching tasks. Innovations such as Minecraft also necessitate a constant upgrading of skills and constant adaptation, which challenges teachers' already limited time (Thorsteinsson & Niculescu, 2016).

This paper reports feedback from teachers who were trained to use WHIMC about the factors that helped or hindered them from using WHIMC in their classes, and the likelihood that they will use WHIMC (again) in the future. By asking teachers for their feedback, we assess WHIMC's sustainability. Is it likely to continue being a useful tool for teachers and students in Philippine classrooms or will first- or second-order barriers become so insurmountable that the use of WHIMC is more likely to fizzle out as so many education technology initiatives do?

3. Data Collection

3.1 Participant Selection

All of the partner teachers were endorsed by the researchers' institutional partners and teacher participants who attended the module development training using WHIMC under the project were invited to participate voluntarily in an online focus group discussion (FGD) session. The module development training provided varied, as there were school schedules that allowed a five-day online training while others had only one full working day available but held on-site in the school's own laboratory. In general, the format of the trainings held provided first a short orientation about the educational framework of WHIMC, a discussion on the features of Minecraft, and a short demonstration on how to navigate through the WHIMC worlds. Then, the teachers were provided an opportunity to initially explore the WHIMC worlds assigned using lent Minecraft accounts and a training guide. The training guide contained three to five guide questions for each WHIMC world that would allow the teacher participants to look into the content and environment of the WHIMC world. After being able to explore the WHIMC worlds, the teachers were given the space to design and draft their learning modules for their own classes. This was done individually for some schools, while other schools designed a module as a group according to the grade level they taught. The presentation included a feasibility assessment by the teacher on whether they could fully implement and integrate Minecraft in their classes. Afterwards, everyone is given a chance to present their module drafts to the rest of the participants and trainers, and hear feedback about how they could improve the module developed. Finally, the trainers gave an orientation on how to prepare their classes for a WHIMC lesson.

Upon invitation to attend the FGD, the teachers were provided session schedule options with a maximum of 1.5 hours each session. The confirmed FGD participants were sent an electronic calendar invite with an online conference link where the FGD would be held at least two weeks before the FGD session schedule they had chosen. On the FGD session schedule, the teacher participants gathered at the online meeting room hosted by the project manager and the project leader.

3.2 Focus Group Discussions

The project leader and project manager prepared a presentation and an online word document for the FGD. The online word document served as the main data gathering tool to collect the FGD participants' basic information and notes on their responses to the FGD questions.

The session began with the project manager and project leader welcoming the participants. The project manager proceeded to state the session objectives, which was "to identify the factors that motivate or hinder the implementation of a WHIMC module in the classroom. During the FGD, participants were given five (5) minutes to post their responses the question applicable to their situation on the Google Doc file provided. The project manager and project leader facilitated the discussion in the online meeting room, where the participants were given the space to share about their responses to the group.

There were two (2) questions raised during the online session. The first question was applicable to the teachers who had already developed and implemented a lesson plan in at least one class, and read by the project leader or manager, “If you implemented a WHIMC lesson plan before, would you implement it again? Why or why not?” The other question was applicable to the teachers who had not implemented a WHIMC lesson plan yet, and asked “If you did not implement one before, why? Would you implement one now? Why or why not?”

4. Results and Discussion

The project team was able to interview a total of nine (9) participants, five (5) male and four (4) female basic education teachers, working in Philippine private and public basic education institutions. The participants had an average age of thirty-five (35) years old, with an average of eleven (11) years of basic education teaching experience, and an average of ten (10) years of teaching a STEM-related subject.

Four (4) teachers who were trained to use WHIMC did not pursue the implementation of a WHIMC lesson plan in their actual classes. The remaining five (5) did so. All of them expressed that, if given an opportunity, they would implement a WHIMC lesson in their classes again. One female teacher from a private school shared that she had observed the depth of learning from her students as they used WHIMC in their class. The students’ discussion went beyond the intended topic, and had seen how theoretical concepts actually happen through their exploration inside the WHIMC worlds. She also observed that it developed their affective and social skills, since the students were able to play, communicate and collaborate on their movements within the WHIMC Java Edition server during their online WHIMC class. Two (2) other teachers expressed that they would choose to implement a WHIMC lesson as a supplement or enrichment activity in their classes. For example, it was shared by one of them that there are topics, such as the solar system, where it is difficult to think of experiments for. Thus, the WHIMC worlds exploration could be a good tool to help the students learn deeper about the topic. Then, one teacher from a public school shared that she saw how eager the students were during class which encouraged her to plan for another WHIMC lesson.

The first-order barriers cited by both groups of teachers were similar:

1. **Logistical impediments.** Given that the schools only have a common computer laboratory, which was usually used for the computer education subject, venue availability for a WHIMC class was seen as a concern. It was raised that the school would hopefully increase the computer laboratories and/or update their policies to allow the students to bring their own devices or laptops.
2. **Lesson scheduling.** The WHIMC lessons tended to be quite lengthy, exceeding the usual class period length for some schools. One teacher noted that they had limited contact time with the students within a week (e.g. three times a week to teach one module). The challenge to teachers was to integrate WHIMC into these limited time slots. Having more time would make implementing a WHIMC module more feasible.
3. **Technical resources.** For schools that implemented a WHIMC lesson through an online modality, it was said to be more convenient if the school had available computers to lend to avoid any delays in the student’s accomplishment of the WHIMC class’ activities.
4. **Curriculum alignment.** Of the four (4) teachers who were not able to implement a WHIMC lesson, three (3) were assigned to teach computer education. Their curriculum goals and competencies were not aligned to the content of WHIMC, and focused on other STEM areas such as robotics and programming. Meanwhile, for one of the teachers under this group that taught Science (specifically, Physics), it was raised that the developed module during the teacher training was not fit for the lesson topics his class had in the pipeline.
5. **Changes in teaching and learning modalities.** Throughout the school year, policies on the teaching and learning modalities have constantly shifted due to the changing COVD-19 restrictions, to which the schools adjusted to every now and then. The change from flexible learning, partially on-site and fully on-site classes affected the lesson planning of the teachers.

The second-order barriers cited by both groups of teachers included the following:

1. **Limited time to practice the lesson design or for dry runs.** Teachers said that they had limited time to explore WHIMC and practice their lesson designs. Additional time to practice would give them more chances to think of and implement WHIMC-based lesson in their classes. They could also use the time to improve upon the lessons that they had already created.
2. **Concerns about classroom management.** Related to the second first-order barrier, teachers expressed anxiety about how they would manage a WHIMC-based class during a 50-minute class period. They were not sure they would be able to orchestrate a proper exploration of the worlds, given the limited time.

The teachers did have some suggestions about how these barriers could be overcome. They suggested that WHIMC training be made available to more STEM teachers. This creates a community of practice whose members can work together on common lesson plans, thereby allowing the school to implement WHIMC-based lessons across more sections of a grade level, as the STEM subjects are usually taught by multiple teachers.

5. Conclusion

We found that for both groups of teachers, those who were and were not able to implement a WHIMC lesson, encountered similar first- and second-order barriers. They noted the feasibility of running a WHIMC lesson in their classes was hindered due to logistical, technical and curriculum concerns. To be able to address said barriers, the school administration's support is needed to be able to realize the material and content support needs of the teachers. The difference seemed to be that those who were able to implement were also able to overcome the limited time for practice and any anxieties they might have had about classroom management. The teachers did not mention barriers similar to the ones cited in prior literature (see Thorsteinsson & Niculescu, 2016) but it is consistent with some of the findings of general impediments to the use of technology in developing world classrooms (see Rodrigo, 2021).

In summary, to successfully sustain the implementation of Minecraft-based lessons, it requires the support of school leadership for the needed facilities and technological infrastructures. Having a community of teachers that are equipped to develop and manage such kinds of lessons is also important to push for the institutionalization of lesson plan development and implementation. Additionally, having a more stable mode of teaching and learning as well as a community of practice would allow teachers to successfully plan and consider integrating Minecraft in their class topics.

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