Relationship Between Students' Minecraft Re-engagement Metrics and STEM Interest

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Abstract: We determine the relationship between student STEM interest and four re-engagement metrics within a set of Minecraft worlds: number of concurrent players playing outside of class hours, number of observations made, number of worlds visited, and number of science tools used. With the exception of number of observations made, there were no significant relationships found between STEM interest and these re-engagement metrics. Therefore, the data so far does not provide much evidence that these behaviors are indicative of interest in STEM. Ways forward include later administration of the STEM interest questionnaire, hypothesizing other in-game behaviors, and identifying a more sensitive STEM interest instrument.

Keywords: WHIMC, Minecraft, re-engagement, Philippines

1. Introduction

The What-If Hypothetical Implementations in Minecraft (WHIMC; https://whimcproject.web.illinois.edu/) are a set of Minecraft-based simulations that immerse students in alternate versions of Earth. They pose questions such as "What if Earth was tilted on its axis?" or "What if Earth had two moons?". The students then explore these Earths in order to observe how climate, geography, and life forms would differ because of these varying circumstances. A team from the Ateneo de Manila University (ADMU) partnered with WHIMC's originators at the University of Illinois Urbana Champaign (UIUC) to deploy WHIMC in Philippine classrooms. The goal of the ADMU team was to use WHIMC to cultivate student interest in STEM.

In order to measure the impact of WHIMC on student interest, the work of Casano, Fuentes, and Rodrigo (2023) investigated the concept of re-engagement. A learner is said to be re-engaged if he/she interacts with a learning intervention without a teacher's prompting. Student engagement takes place when the students use the intervention because he/she is required to do so, during a time that the teacher designates. Casano et al. note that prior studies of student use of Minecraft tends to focus on engagement and sustained engagement, which usually span from the time Minecraft is introduced in a class to the time the students are asked to answer post-intervention questionnaires. While there is some work on student re-engagement with Minecraft, it is not as extensively studied.

Casano et al. (2023) operationalized re-engagement in WHIMC as social play, free exploration, observations made, and science tools used. In this paper, we determine the relationship between these metrics and STEM interest. A student's social play score was equal to the number of overlapping play sessions, i.e. the number of concurrent companions playing WHIMC with the student outside of teacher-mandated hours. Free exploration was operationalized as the number of worlds the student visited, both during and outside of teacher-mandated hours. Number of observations referred to the count of the observations logged by the student. Finally, the use of science tools referred to the number of times students measured different characteristics of the worlds they visited. The goal of this paper is to determine how these re-engagement metrics relate with student STEM interest.

2. Methodology

The data analyzed in this paper was from eighth-grade students from eight different sections of a private school in the southern part of the Philippines. Their teachers received training on the use of WHIMC, after which they crafted their own modules. These modules underwent a process of review in which curricular alignment and quality were checked. A full discussion of the preparatory process is available in (Manahan & Rodrigo, 2022). After revision, the teachers conducted these lessons with their students.

There were five types of data collected from the students. We collected demographic data about the students' age, gender, school, and school section. WHIMC automatically logged student interactions with the system. Data from these logs included the student's position in the world, what observations the student made, and what tools the students used. The students also completed three types of questionnaires. A STEM interest questionnaire (SIQ) was given to students before and after the use of WHIMC. This questionnaire asks students questions about their perceived ability in STEM, their perceived future use of STEM, and their interest and value for STEM. A Game Experience Questionnaire (GEQ; IJsselsteijn & De Kort, 2013) asked students how engaging the game experience was. Finally, Knowledge questionnaires were created by the teachers as part of their lesson planning. Both the GEQ and the Knowledge questionnaires are excluded from the scope of this paper.

There were 175 students who participated in the WHIMC lessons. The dataset for this analysis was composed of the following fields:

- Demographic data: Gender, Age
- Questionnaire data: SIQ Pre-test score, SIQ Post-test score, Difference between SIQ Post-test and Pre-test
- WHIMC log file data: Used WHIMC outside of class (Yes/No), Number of concurrent users during use outside of class, Number of observations made, Number of science tools used, Number of worlds visited outside of class

We removed students with incomplete pre- and post-test data, leaving a total of 131 students for this analysis. Of these 131 students, 58 were male and 73 were female. Their ages ranged from 13 to 15 years old.

3. Analysis and Results

To understand how STEM interest changed and how it related with re-engagement, we first performed a paired t-test to determine whether the SIQ scores of the students changed significantly. While the post-test scores were slightly higher on average (3.6) than the pre-test (3.5), the difference was not significant ($t(254.68)=-1.02$, $p=0.3$). This is consistent with Tablatin, Casano, and Rodrigo's (2023) analysis of a subset of this data, which also showed no significant difference. This implies that using WHIMC did not influence students' interest in STEM.

There were no statistically-detectable gender differences. Male and female students did not differ significantly in terms of their pre-test scores ($t(123.31)=0.63$, $p=0.5$), post-test scores ($t(127.14)=-0.56$, $p=0.58$), or their post- and pre-test difference ($t(115.38)=1.43$, $p=0.16$).

For the next analyses, we treated the population as a whole and only used the SIQ post-test scores as the outcome variable.

We first attempted to correlate the SIQ post-test scores with the number of concurrent companions, the number of observations, number of science tools used, and the number of worlds visited. All of these correlations were negligible.

We then tried to divide the population into different terciles based on each of the metrics. That is, we first sorted the number of concurrent companions and then divided the population into the top, middle, and bottom third. There should have been 43 to 44 students per tercile. However, if a cluster of students at the border of two terciles had the same scores, we assigned the cluster to either the higher or lower tier, depending on what would result into as balanced a split as possible. We then performed an ANOVA and a Tukey

Honestly Sigificant Difference post-hoc analysis to determine if there were differences in SIQ post-test scores among the different terciles.

There were no significant differences among terciles of for the number of concurrent companions (f(2)=1.83, p=0.17), number of science tools used (f(1)=0.73,p=0.4), or number of worlds visited (f(2)=0.36,p=0.72).

For the total observations, there were 75 students with no observations at all and 57 students with at least one observation. Instead of splitting this group into terciles, we split the group into two—those with at least one observation and those with no observations. We found that the students who made no observations had lower SIQ post-test scores than those who made at least one observation (t(128.42)=2.08, p=0.04).

4. Conclusion

The results of the analysis are disappointing. With the exception of number of observations made, none of the re-engagement metrics had a statistically detectable relationship with SIQ scores. The data did not provide evidence in favor of these measures of re-engagement. One possible explanation was that the SIQ post-test was given before the students re-engaged with WHIMC. It is also possible that the exposure to WHIMC was too brief to encourage or inspire greater STEM interest. In future research, we could ask students to complete the SIQ again, several weeks after they complete the WHIMC lesson. We could also search for other in-game behaviors that might be indicative of STEM interest. Finally, we could search for a more sensitive measure of STEM interest, other than the SIQ.

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