Coding and Analyzing Scientific Observations From Middle School Students in Minecraft

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Abstract: The importance of promoting interest in STEM is crucial to the recruitment and retainment of underrepresented populations in the STEM field. We coded scientific observations made by participants from a one-week summer camp program centered around astronomy using Minecraft, breaking down the types of scientific observations and their level of quality using Cohen's Kappa. Results showed that the majority of observations are descriptive, comparative, inferential, or analogous, as opposed to being off topic or factual. We discuss possible reasons for this distribution and design implications for future reiterations.

Introduction

Triggering interest early and subsequently supporting that interest is important, if long-term individual interest is to develop (Hidi & Renninger, 2006). The context for our research is the popular game Minecraft, which allows players to exercise free choice and engage with a simulation of the natural world (Lane & Yi, 2017). Notably, interest in STEM tends to wane prior to entering high school (Maltese & Tai, 2011), hence we target our camp recruitments at early adolescents. In this paper, we discuss observations collected over two weeks of camp and describe our coding scheme that sorts scientific observations by the quality of the observation, shedding light on what catches campers' attention and their sensemaking. Identifying the quality of scientific observations from campers allows detection of interest triggering instances and enables a digital roadmap of interest development (e.g., as a camper's quality of observation increases, we can examine if their interest in science increases as well).

Methods

Sample and data collection

The camp took place at a nonprofit community center in partnership with a university-affiliated makerspace in the Midwest. We hosted 21 participants in total (females = 8) between the ages of 11- to 14-years-old and all qualified for free and reduced lunch. All identified as African American except one Caucasian American. We conducted two 1-week camps in the summer of 2019. Campers were presented brief 10-minute lectures on hypothetical scenarios of earth before exploring such worlds within Minecraft. Data logs were generated following the summer camp programs of: 1) scientific observations made by campers through Minecraft signs that allow users to write messages for others to see, 2) the exact location occupied by users, which included the version of earth occupied and exact coordinates, and 3) the date and time of the made observation.

Coding

The authors decided five initial codes developed did not adequately capture the nuance in the data and expanded to the ten codes of scientific observation categories used in this paper. We organized categories by their level of sensemaking and reliance on external knowledge: factual observations and off-topic comments are the lowest level, followed by descriptive and comparative as mid-level, and inference and analogy as the highest level of active sensemaking (see Table 1). Two of the authors coded 200 lines of observation data and the measured Cohen's Kappa for our results was .87, indicating a strong agreement.

Table 1: Codes used to describe scientific observations

Category	Definition	Quality
Factual (low)	Stating nouns without any elaborations.	N/A, direct observation ("carrots")
Off-topic (low)	Technology-related, conversational.	N/A, irrelevant to task ("smoking is good")
Descriptive (mid)	Related to color, temperature, quantity, and other physical attributes such as weight or size.	Clear ("lots of coral") Ambiguous ("the water is very nice")
Comparative (mid)	Comparing one natural phenomena to another; expectations are violated.	Clear ("different color grass") Ambiguous ("the trees are different")

Analogy (high)	Comparing natural phenomena with another similar structure or object; an advanced form of comparative.	Clear ("tumble weed looking plant") Ambiguous ("the trees look like animals")
Inference (high)	A hypothesis or explanation is proposed.	Clear ("trees grow because probably facing the sun a lot") Ambiguous ("climate change")

Results

The percentage breakdown of scientific codes is summarized in Table 2. We found that 36% of observations were low level, including factual statements and those that were off-topic. Comparative observations were 22% of the data, with about 73% clear scientific connections while 27% were ambiguous. We expected inferences and analogies to have the lowest count and this was affirmed in our findings. Inferences were 5% of the data set, and out of those 89% were clear scientific connections and 11% ambiguous. Analogies were 3% of the data set, with 60% clear scientific connections and 40% ambiguous. The remaining 6% of observations were disagreements.

Table 2: Summary of scientific observations from 200 lines of data excluding inter-rater disagreements

Category	Factual	Off-topic	Descriptive	Comparative	Analogy
Percentage	34.95	3.76	30.11	23.66	7.53

Discussion

We consider this intervention with an underrepresented population a successful pilot with more than half of the observations made in the data set belonging to a higher level of active sensemaking, including descriptive, comparative, inference, and analogy. The majority of descriptive observations and inferences were clear, with more ambiguity in comparative and analogous statements. The ambiguity in comparative and analogous statements may be due to campers recognizing differences between the maps, but not being sure of the reason for the differences. Despite 33% of scientific observations being factual, we currently do not have evidence that this is necessarily depriving campers from making higher level observations. For instance, does the act of making factual statements lay out a foundation that eventually leads to inferences or analogies? We also credit the success of this pilot to the flexibility of sandbox games. It was through Minecraft's ability to handle custom modifications that allowed compare-and-contrast of specific features within our worlds.

The importance of this research is to show that engagements with natural phenomena is possible in an open space digital environment and that sandbox games have the potential to help spark interest in STEM topics for underrepresented adolescents. Future camp reiterations will track camper comments to see the progression of comments made by each individual camper. Through analyzing this data, we should be able to capture if campers generated more high-quality scientific observations as they progressed through the camp. Additionally, we hope to combine these types of scientific observations made by learners with other sources of data, such as exploration patterns on our server maps, survey data pertaining to STEM interest, Minecraft play patterns, and interview content to help inform our intervention design. Lastly, we are working on the development of pedagogical agents that will help scaffold the camp experience in hopes to increasing the overall quality and quantity of observations.

References

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Acknowledgments

We would like to express gratefulness to Dr. Neil Comins for consulting on astronomical topics and to our technical team comprised of Dr. Jeff Ginger, Jack Henhapl, and Aidan Rivera-Rogers, for their immense contributions to this project. This material is based upon work supported by the National Science Foundation under Grant No. 1713609. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.