Doctoral Student Research Briefs
School of Education
Drexel University

Research Brief 9

Learning by Making:
Tracking STEM interest development through a play-based informal learning experience

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Volume 3 Number 12 May 3, 2019

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Abstract

The prospective US workforce currently lacks the requisite STEM career interest to provide a competitive STEM workforce on the global scale. Research concerning making activities, including 3D-printing, laser cutting, and modular electronics, have suggested these approaches as one potential means to cultivate STEM identity and interest. This study aims to understand the extent to which learning by making activities can contribute to students' STEM interest development within an environmental science course. Data analysis was conducted using thematic analysis and a deductive coding process based on the Four Phase Model of Interest Development. Findings illustrate the extent to which maker activities played a role in maintaining and cultivating further interest development by highlighting one participant case.

Introduction

National projections indicate that the United States will soon face shortages in the supply of qualified STEM labor (Joint Economic Committee, 2012; Kitchen, Sonnert, & Sadler, 2018). US students demonstrate neither the requisite STEM career interest nor academic preparedness to supply an innovative and competitive STEM workforce on the global scale (Bottia, Stearns, Mickelson, Moller, & Parker, 2015). These trends have led to calls for a stronger and more coordinated investment in STEM education programs nationwide. Making activities, including manufacturing technologies (e.g. 3D printers, laser cutters, e-textiles) and traditional activities (i.e. LEGOs, building blocks, arts and crafts), have become incredibly popular in recent years due to their affordances for developing STEM interest and identity (Shah, Petrovich, Foster, Schaar, & Chen, 2019). Despite the influx of research in learning by making, there is a dearth in research targeting how making activities enable interest development over time (Ramey & Stevens, 2018). For the purposes of this study, interest can be characterized by increased attention, effort, and affect experienced in a particular moment (situational interest), as well as an enduring predisposition to re-engage with a particular object or topic over time (individual interest; Hidi, 2006; Hidi & Renninger, 2006). In order to analyze the effect of maker activities on students' interest development in STEM disciplines, the following research question was posed:

To what extent can learning by making influence change in a student's STEM interest over a 4-week environmental science course?

Methods

Setting and participants. This study was conducted at an environmental education center in a Northeastern US city. The center offers programs to school aged children (K-12) all year round through partnerships with local schools, some of which focus broadly on STEM, and some specifically on environmental science. The participants consisted of 18 high school students evenly distributed between male and female. Participants were recruited purposively as they had volunteered to take part in a course surrounding learning by making and environmental science and art. In order to address the research question, data retrieved from one specific case was analyzed: Avi (a pseudonym), a 14-year old male who identifies as Latino.

Data collection and analysis. For the purposes of this study, data collection consisted of weekly student journals which prompted reflections across students' knowledge, interest and values, self-perceptions and self-definitions, and self-organization and self-control as it related to environmental science and art (Shah, Foster, & Barany, 2017). Additional data collection methods including student artifacts, such as sketches and design drawings, were utilized along with researcher observation notes and recorded video. Thematic analysis was employed as a means to identify, analyze, and report patterns within the data (Braun & Clarke, 2006; Hsieh & Shannon, 2005). Hidi and Renninger's (2006) Four Phase Model of Interest Development was utilized to aid in the deductive coding process. The model elaborates on situational and individual phases of interest to include: Triggered Situational Interest, Maintained Situational Interest, Emerging Individual Interest, and Well-developed Individual Interest. Each phase is characterized by varying levels of affect, knowledge, and value. Without continued support, or sufficient interest development, interest can regress to a prior phase or disappear entirely.

Research Findings

Avi began prior to the intervention and into weeks 1 and 2 at the level of maintained situational interest (Figure 1). Despite this, his week 1 and 2 feedback did not elevate him to subsequent interest phases. While he persisted through frustrations and continued to engage within the classroom, he reported no interest gains in these weeks. In week 3, a week on invasive species management, Avi explicitly stated an interest in the Spotted Lanternfly. In addition, he demonstrated value for environmental science by stating that we could lose the environment if invasive species were allowed to persist unchecked. He also began posing curiosity questions to environmental educators based on the work completed on that day. In week 4, Avi continued to re-engage with maker tools. Following the completion of his project, Avi sought instruction from an environmental educator and began asking questions that fell outside the scope of the environmental science course. He asked to see insects, feathers, and seed samples that were stored in the education center's classroom. In addition, he inquired about additional opportunities to visit and even work at the education center as a summer camp counselor. Avi's growth and actions demonstrate that he ultimately reached the level of well-developed individual interest by the end of the intervention.

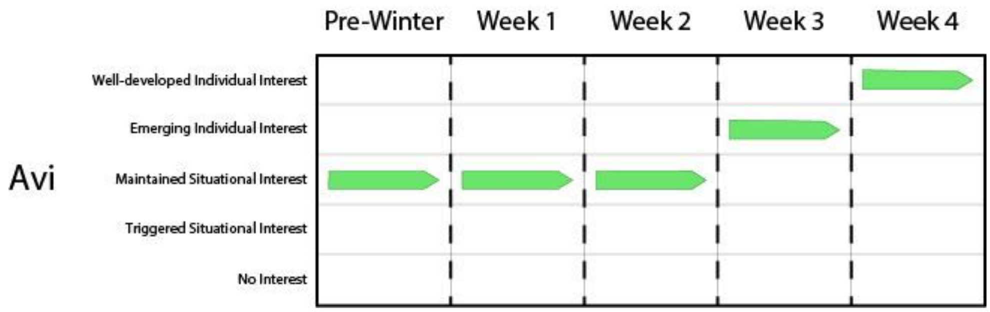

Figure 1. Avi's progression through Four Phase Model of Interest Development

Conclusion/Discussion

In addressing the research question, this study highlights several factors. First, based on the case examined it can be determined that interest evolves gradually. That is, no phases were skipped while undergoing continued instruction. Interest also developed as a result of particular stimuli. For Avi, it was the introduction of invasive species such as the Spotted Lanternfly. Additionally, this study illustrated several contributions provided by learning by making activities. For example, making activities were instrumental in cultivating situational interest when other students explicitly expressed little interest in the study of environmental science. Maker projects also provided opportunities for Avi to maintain his level of interest by re-engaging with content prior to the lesson on the Spotted Lanternfly. Ultimately, making activities were utilized as a means to scaffold students from learning by making towards independent engagement, personal valuing, and reflection on environmental science disciplines.

Implications

This study has provided an opportunity to evaluate how learning by making can be utilized as a tool to foster student interest in STEM disciplines, specifically environmental science. However, the limited scope of the Four Phase Model of Interest Development prevents analysis of minute changes in interest across phases. For example, Avi stagnated for at least two weeks in terms of his interest in the intervention. This is partially true because the Four Phase Model lacks a means to evaluate interest fluctuations within each phase. Alternative interest theories (e.g. Azevedo, 2011) suggest a flow of interest between subjects, as opposed to the content specific interest presented by the Four Phase Model. Future research should target the extent to which students change within and across interest phases and content disciplines.

Acknowledgements

The study reported in this paper was supported by the Drexel University School of Education Faculty Research Initiative project *Facilitating 21st century knowledge and skills and* *motivation to learn through STEAMulating play-based experiences in informal settings.* I'd also like to thank Dr. Aroutis Foster, Dr. Mamta Shah, and Raja Schaar for their contributions and mentorship in making this study possible.

Researcher Bio

Mark Petrovich Jr. is a doctoral student in the Education program with a concentration in STEM education. He is a research assistant within Drexel University's School of Education as well as a member of the Games and Learning in Interactive Digital Environments (GLIDE) lab. His research interests include educational technology, informal learning, maker-centered learning, motivation, and identity exploration. Mark earned a BS/MS in Digital Media from Drexel University in 2012. Since that time, he has served as an adjunct professor in the Digital Media department and a freelance designer for projects involving web development, user interface/user experience design, and video production. His current research examines teaching and learning within informal contexts using immersive technologies such as augmented and virtual reality.

References

Azevedo, F. S. (2011). Lines of practice: A practice-centered theory of interest relationships. Cognition and Instruction, 29(2), 147-184.

Bottia, M. C., Stearns, E., Mickelson, R. A., Moller, S., & Parker, A. D. (2015). The Relationships among High School STEM Learning Experiences and Students' Intent to Declare and Declaration of a STEM Major in College. Teachers College Record, 117(3).

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77-101.

Hidi, S. (2006). Interest: A unique motivational variable. Educational research review, 1(2), 69-82.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. Educational psychologist, 41(2), 111-127.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. Qualitative health research, 15(9), 1277-1288.

Kitchen, J. A., Sonnert, G., & Sadler, P. M. (2018). The impact of college-and university-run high school summer programs on students' end of high school STEM career aspirations. Science Education, 102(3), 529-547.

Ramey, K. E., & Stevens, R. (2018). Interest development and learning in choice-based, in-school, making activities: The case of a 3D printer. Learning, Culture and Social Interaction.

Shah, M., Foster, A. & Barany, A. (2017). Facilitating Learning as Identity Change Through Game-Based Learning. In Y. Baek (Ed). Game-Based Learning: Theory, Strategies and Performance Outcomes. New York, NY. Nova Publishers.

Shah, M., Petrovich, M., Foster, A., Schaar, R. & Chen, D. (2019). Change in Role Identity of an Environmental Science Educator Who Desires to Facilitate Learning by Making. In K. Graziano (Ed.), Proceedings of Society for Information Technology & Teacher Education International Conference (pp. 1635-1645). Las Vegas, NV, United States: Association for the Advancement of Computing in Education (AACE).

US Congress Joint Economic Committee. (2012). STEM education: Preparing for the jobs of the future. Washington DC.