Model-Eliciting Activities: Exploring Interest and Cognitive Load

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Abstract* – *The aim of this study is to explore and describe how middle school children's interest in science, technology, engineering, and mathematics (STEM) may be influenced by cognitive load when using model-eliciting activities (MEAs). The researcher will employ a phenomenological qualitative method to explore and describe how cognitive load effects interest in STEM learning when using MEAs.

Keywords—Model-eliciting activities, STEM, cognitive load, K-12

I. Introduction

The aim of this study is to explore and describe how middle school children's interest in STEM may be influenced by cognitive load when using model-eliciting activities (MEAs).

Research has shown that you can excite, interest and teach K-12 students about STEM. Most studies focused on higher grade levels of K-12 and most studies have not examined the use of MEAs with middle school children. MEAs are mathematical models of solutions to real-world problems [1,2]. MEAs were developed by mathematics education researchers to study the evaluation of mathematical problem solving in middle schools. They were then used in introductory engineering courses where they became the subject of several NSF grants [2]. Current research with MEAs involves exploring the use of MEAs with STEM content. This study aims to use MEAs with STEM learning experiences that use agricultural life sciences as a context. Agriculture is linked to biology in the 21st century and arguably a large problem due to meeting food and energy needs for more than nine billion people by 2050 [3]. This problem is also relevant across many different communities and addresses real-world problems.

II. Literature Review

A report by the President's Council of Advisors on Science and Technology, 2010 stated that students who demonstrate proficiency in STEM indicate low interest in STEM. Previous efforts in teaching young students about STEM and in generating interest in STEM have not significantly increased the numbers of students that want to pursue STEM [4]. Prior studies examined the areas of interest, cognitive load, and MEAs in separate studies. For example, some studies looked at interest having a strong and profound effect on learning behavior and intention to participate in the future [5, 6]. There are studies that indicate how interest plays an energizing role on the cognitive functioning [7]. While other studies looked at cognitive load. In the late 1980s and early 1990s Chandler, Sweller, and Mayer examined cognitive load and instructional design, which impacted researchers and instructional designers in the field of education [8, 9, 10]. Lesh (2000) work discuss how MEAs can be used to "emphasize problem characteristics, understandings, and abilities needed for success in real life [9]." Studies have examined the use of STEM related MEAs with middle school children [9, 2]. Furthermore, most studies that have examined interest, cognitive load, and STEM teaching tools all conclude that interest, cognitive load, and instructional design play a vital role in student's mastery of instruction. However, few studies have explored and described how middle school children's interest in STEM may be influenced by cognitive load when using STEM related MEAs. The following research questions guide the exploration of this study:

1. What are some changes to the MEA activity do the students suggest to better reflect a problem in their community, school, home or any other societal problem that they are aware of?
2. What component of the MEA activity does the student like the most and less like?
3. What part of the MEA seems too be hard or too easy?

III. Methodology

The researcher will conduct a phenomenological qualitative study to explore and describe the how cognitive load may influence interest in STEM learning when using MEAs. A phenomenology method approach is chosen because of its affordance to triangulating data sources as a means of seeking convergence across a combination of data sources such as student interviews or focus groups, surveys, video, and observations, to glean a broad understanding of the events explored. The researcher will use pre- and post-interviews and surveys to capture data. Observations and videos will be used to glean a better understating of situated classroom interactions. A key aspect of the pre-survey will be to understand interest and cognitive load, and content knowledge before students engage in the MEA activity. A key aspect of the post-survey will be to better understand changes in interest, cognitive load, and content knowledge after students partake in the MEA activity. The researcher will also incorporate student interviews or focus groups which may contribute to knowledge gleaned about participant's perceptions of their interest and cogitative load when working with the MEA activity.

IV. Participants

The participants for this study are fifth-grade students ranging in age from 10 to 12 years old. The participants will be chosen via a convenience sampling. The participants will attend one of two schools, i.e., one urban school and one suburban school. The rationale for studying fifth grade students is that studies indicate that students are making decisions about their careers as early as middle school but with a lack of interest and information in STEM. Additionally, studies show that students that have an early interest in STEM are three times more likely to obtain a STEM degree. The rationale for studying students from two schools that are situated in two distinctly different environments is to capture the variance between an urban and suburban school district.

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