EAGER proposal for Research in Measurement and Modeling: Dynamic STEM Assessment Through Epistemic Network Analysis

Project Summary

In this project, we lay the ground work for developing a potentially transformational approach to STEM assessment in the 21st century.

Today, work that requires only basic skills flows overseas where labor is cheaper, and complex and meaningful STEM thinking means linking skills and knowledge in the context of real-world problems and situations. Problem solving in real STEM practices is characterized by knowledge and skills, to be sure, but also by the way those skills are connected to each other, and to the values and ways of making decisions in STEM fields.

We propose, then, the development of a new method of STEM assessment—called ***epistemic network analysis*** **(ENA)** that focuses not on whether students master specific scientific facts, math skills, or engineering concepts, but on whether and how students link the skills, knowledge, identity, values, and epistemology of a STEM practice into a coherent way of thinking about complex STEM problems.

We describe ENA as "potentially transformational" because it is in its early stages, and involves a radically different and interdisciplinary approach to the problems of STEM assessment. In this proposal we link prior work on an *innovative theory of STEM thinking* with the mathematical and conceptual tools of *social network analysis* to create a new conceptual and statistical approach to the measurement of STEM thinking and STEM learning.

We have been developing ENA as an assessment tool in the context of a particular theory of learning (the *epistemic frame hypothesis*) that applies to a specific kind of STEM learning computer game (*epistemic games*). However, we want to emphasize ***ENA is an approach to assessment that could be used in any situation of complex STEM thinking where*** **the connections between things being learned** ***are more important than isolated pieces themselves.***

Intellectual Merit

In this proposal, we link work across several domains—including learning theory, psychometrics, and sociology—to develop a new assessment technique designed to measure the impact of technology-based STEM learning environments. This emerging research is, by its nature, uncertain. However, the collective work of the project team—including joint work on the pilot phases of this project—suggests that this research will produce conceptual, theoretical, and methodological results with the potential for far-reaching and long-term impacts on the theory and practice of network analysis, visualization, and their applications to STEM learning.

Broader Impact

The development of the cognitive model proposed here will help educators in a wide variety of fields analyze and improve STEM education by providing a means to dynamically assess the development of complex STEM thinking. The tools we develop will contribute to the field of network analysis, and our development process will enhance the skills and career trajectories of at least five young investigators.