BioSCANN: A Collaborative Learning Platform That Scaffolds Scientific Inquiry in the Context of Interrupted Case Studies

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Abstract: We present BioSCANN, a collaborative learning platform that scaffolds scientific inquiry in the context of Interrupted Case Studies. This technology-enhanced curriculum engages students by integrating experimental design and career awareness in the context of drug discovery. It supports teacher orchestration of scientific argumentation and builds student conceptual understandings, career awareness, and self-efficacy. Preliminary results from six classrooms will be presented, providing insights into facilitating learning and career awareness both with and without technology.

Science, technology, engineering, and mathematics (STEM) education has experienced a shift away from the memorization of facts, figures, and procedures toward engaging students in more authentic science practices and scientific argumentation. In response to this challenge, scholars have advanced the methods of collaborative problem-based learning (PBL) as a pedagogical framework to increase student understanding of science and long-term retention of content, as well as to improve their critical thinking skills, metacognition, willingness to assume difficult tasks, persistence, motivation, and transfer of learning to new situations (Fortus, Krajcik, Dershimer, Marx & Mamlok-Naaman, 2005; Kolodner et al., 2003; Strobel & van Barneveld, 2009). In our own prior research (Jacque, 2015), we have advanced a more structured model of case-based learning using *interrupted case studies* (ICS) that scaffold evidence-based argumentation from scientific data given in piecemeal, building risk assessment skills critical for 21st-century health literacy in high school biology classrooms. By structuring cases into a clear progression, we provide "interruption points" that allow teams of students to stay in sync and give teachers an opportunity for planned or spontaneous whole-class discussions. This format also allows teachers multiple opportunities to pose questions, review student responses, and to use those responses to address student conceptions and to model answering questions appropriately (Herreid, 2005).

The ICS approach can be challenging for teachers and to address this we have developed a web-based interactive learning environment called *BioSCANN* that scaffolds *ICS-based* learning scenarios that engage high school students in collaborative scientific inquiry and argumentation. The BioSCANN technology environment can be used to author a unique workflow for an ICS that allows students to progress through set points of reflection. At each step in the ICS, students use the Question-Method-Data-Conclusion framework to assess their scientific argumentation. Students document their thinking and work in BioSCANN's collective knowledge space and use this to discuss and debate issues. After making a decision based on data, the team then elects the next path to take, allowing for a choose-your-own-adventure, game-like feel that inspires ownership. In this way, BioSCANN responds to the challenges of enacting ICS by: (1) allowing for multidirectional decision making – in which students can choose their own path of inquiry; (2) providing distinct content to each group to encourage classroom discourse; (3) utilizing interactive technologies for group decision-making and reporting to the class; (4) creating a common data and results archive that supports teacher facilitation of scientific argumentation (SA). *BioSCANN* provides scaffolding that mimics the step-by-step iteration of scientific discovery and practices, while providing instructors with opportunities to manage discourse.

In its current iteration, the BioSCANN curriculum is a five-day experience in which high school students are placed in teams that each play a distinct role as a member of a drug discovery team (animal care technician, financial consultant, research scientist, and medicinal chemist). The curriculum challenges students to work together in groups to design a new drug to combat HIV.

The BioSCANN web platform facilitates the three phases of the ICS process: <u>Exploration:</u> Student groups use career-relevant information (roles) in the context of the specialized experimental methods and data and are asked to solve the challenge of the day. Each group has only a small piece of the data needed to reach a comprehensive class-wide conclusion. In this phase, the teacher takes on the role of 'guide at the side'. <u>Discourse</u>: The entire class then coheres as a knowledge community to critique, debate and revise explanations, and make decisions guided by the teacher. In this phase the teacher takes on the role of 'mentor at the center,' orchestrating class-wide student discourse while, modeling the process of SA. <u>Synthesis</u>: Students then utilize evidence (data), to draw conclusions and explanations to select the next step they will take as a design team. In this phase, the teacher reprises their 'guide at the side' role as students return to their groups to synthesize findings and ideas and to formulate the questions that will form the foundation of the next iteration of the three phases of the ICS. In short, BioSCANN acts as a scaffold for scientific argumentation via ICS and is a tool to facilitate the community's inquiry process.

The major research goals of this project are to better understand a) how to engage a broad range of students in STEM-cognate careers and 2) to increase their skills in data interpretation and evidence-based problem solving. In the first year of the project, we worked towards this goal by adapting a measure of career interest and goal setting, Social Cognitive Career Theory (SCCT), provided to us by Dr. Robert Lent, one of the scholars who created the theory. This new tool measures Self Efficacy (SE), Outcome Expectations (OE), Interests, and Career Goals, with the addition of items that target bioscience career awareness and awareness of education and training pathways for bioscience careers. We used a similar process to develop an instrument to measure corresponding factors in teacher participants. For example, we believe that how a teacher perceives their student's capacity might correlate with student's self-perception

We administered the SCCT instrument as a pre- and post-test with a sample of 19 high school students who participated in a summer 2017 pilot. Knowing that the student participant's in the pilot are self-selected, we also compared their responses to a group of age-matched high-school students who did not participate in the pilot. We found that in all cases, the pilot participants reported significantly higher SE, OE, and Interest than the comparison group (unpaired t test, p = SE <.0001, OE 0.0002, Internest 0.003). This is expected given the self-selecting nature of recruitment for the pilot study. Importantly, we did not see a significant difference between the pre-tests scoring of Goals of the pilot student participants and the comparison group (unpaired t test, p = .83). However, there was an increase in pre-to post Goals following participation in the pilot (paired t test p = .039). When looking at items from the new construct - Bioscience Career Awareness (CA), we saw the most dramatic patterns and effects. Students showed significant gains in pre-post awareness of a number of other bioscience careers and an increase in their overall awareness as well (paired t test, p = <.001).

This poster is directly related to the conference theme of "*exploring learning in real-world settings in an interdisciplinary manner in order to understand how learning may be facilitated both with and without technology"* by showcasing impacts on students participating in BioSCANN. Our development of BioSCANN has not only highlighted the challenges of such pedagogical technology environments, it has also revealed vital new opportunities for engaging teachers in the orchestration of a classroom learning community. Therefore, it will unpack the role of technology in providing students with instructional "scaffolding" and a set of tools that promote team-based discourse and knowledge building that resemble the iterative nature of scientific discovery and practices. We will also address a key challenge when using this approach: there is a danger that the teacher's role will be subsumed by ensuring that the technology functions smoothly and students are staying "on task." Moreover, from classroom evaluations of BioSCANN we have come to recognize that much of the underlying pedagogy of ICS is hidden from teachers - implicit within the technology environment. Thus, teachers may not fully exploit the ICS format as they guide the exploration, discourse and synthesis phases of the ICS.

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