SIGCSE 2019 Demo Proposal

Proposer:
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Title: Integrating Computational Modeling in K-12 STEM Classrooms

Abstract:
C2STEM is a web-based learning environment founded on a novel paradigm that combines block-structured, visual programming with the concept of domain specific modeling languages (DSMLs) to promote the synergistic learning of discipline-specific and CT concepts and practices. Our design-based, collaborative learning environment aims to provide students in K-12 classrooms with immersive experiences in computational thinking (CT) through computational modeling in realistic scenarios (e.g., building models of scientific phenomena). The goal is to increase student engagement and include inclusive opportunities for developing key computational skills needed for the 21st century workforce. Research implementations that include a semester-long high school physics classroom study, have demonstrated the effectiveness of our approach in supporting synergistic learning of STEM and CT concepts and practices, especially when compared to a traditional classroom approach. This technology demonstration will showcase our CS+X (X = physics, marine biology, or earth science) learning environment and associated curricula. Participants can engage in our design process and learn how to develop curricular modules that cover STEM and CT (CS) concepts and practices. Our work is supported by an NSF STEM+C grant and involves a multi-institution team, which includes Vanderbilt University, SRI International, Looking Glass Ventures, Stanford University, Salem State University, and ETR. More information, including demo computational modeling tasks, can be found at C2STEM.org.

Significance and Relevance of the Topic:
Computation is now considered the third pillar of science and engineering disciplines, alongside theory and experimentation. Computing knowledge and skills provide the foundation for modern competency in a multitude of STEM (Science, Technology, Engineering, and Math)-related disciplines, prompting research in CS+X on how to best prepare students for the 21st century workforce and for lifelong learning. The Next Generation Science Standards (NGSS) have reinforced the importance of model-based STEM instruction as a means of engaging students in more authentic STEM practices. Technology-enhanced models can be used as a productive avenue for engaging students in computational model building, and then using these executable models to solve problems in the particular STEM domain. However, building computational models of scientific phenomena is a multifaceted process that requires a good grasp of STEM domain and CT knowledge, as well as higher-order thinking skills like abstraction and decomposition. Past research has shown that students face significant difficulties in the translation of their STEM knowledge into a computational representation.

Our C2STEM environment is designed to limit these difficulties through key technology and curricular scaffolds with the goal of integrating computation into K-12 STEM classrooms. To do so, we implement four key design principles, including: (1) evidence-centered assessment

and curriculum design, (2) a domain-specific modeling language (DSML) implemented in a visual programming environment (NetsBlox, a block-based extension of SNAP!), (3) exploratory learning of dynamic processes, and (4) embedded (formative) and preparation for future learning (PFL) assessments to support and analyze student learning. Our approach has proven to be effective in supporting learning gains in implemented STEM classrooms. We believe this approach can support a more generalizable, inclusive application of computational modeling and CT in STEM and can provide teachers with a unique, classroom-centered approach to modeling and discussing STEM phenomena in their classrooms.

Expected Audience:

- Teachers and students interested in programming as a means of CT education.
- Education researchers exploring news ways to teach and integrate CS and CT.
- Developers working on various visual and block-based programming environments.

Other Presenters: Nicole Hutchins; Akos Ledeczi, Ph.D.; Shuchi Grover, Ph.D.

Expertise of Presenters:
Nicole Hutchins is a PhD student in Computer Science at Vanderbilt University. She was a high school computer science teacher prior to joining Vanderbilt.

Akos Ledeczi is a Professor of Computer Engineering at Vanderbilt University. His research covers a wide area from model-based development to wireless sensor networks. His recent interest focuses on CS education. More info about Akos is available at: http://isis.vanderbilt.edu/akos

Shuchi Grover, Ph.D. is a learning scientist and CS education researcher. Her research focuses on examining pedagogies and designs of learning environments to teach CS and CT integration in K-12 curricula. More info about Shuchi and her research is available at shuchigrover.com

Gautam Biswas is a Professor of Computer Engineering at Vanderbilt University. His research covers research studies with open ended learning environments, synergistic learning of STEM and CT, and using analytics and mining to study students' learning behaviors.

Rough Agenda for the Demo:
0-10 minutes: Introduction to C2STEM
10-20 minutes: Discussion and Demo of the Physics Curriculum
20-30 minutes: Discussion and Demo of the Marine Biology/Climate Change Curriculum
30-35 minutes: Demonstration of the How to Design C2STEM Modules for the Classroom
35-45 minutes: Questions from the audience

Audio/Visual and Computer Requirements:

1. Wireless/Ethernet access and power socket required (a laptop will be brought, and we need to connect to the internet)
2. Projector to display the screen of the computer/laptop above