Innovative Assessments for Operationalizing and Measuring Students' Computational Thinking

This session will highlight innovations in assessing K-12 computational thinking (CT). As an emerging construct, the definition of CT is generally characterized as the thinking processes involved in formulating problems and their solutions in a form that can be effectively carried out by an information-processing agent (Wing, 2006). The thinking skills involved in this process include abstraction, decomposition, evaluation, pattern recognition, logic, and algorithm design (Grover & Pea, 2017). This session brings together researchers representing four innovative approaches to assessing CT, each of which provides teachers with useful information to guide instruction. Each presentation will describe the operational definition of CT for the assessment, development and validation work, and how teachers use assessment results to guide K-12 instruction.

Measuring Young Children's Learning of CT Skills

Our work involves developing a series of scenario-based assessment tasks designed to draw inferences of young children's learning of CT, specifically, problem decomposition, algorithmic thinking, abstraction, and detecting errors/debugging. We will discuss the design of age-appropriate assessment items as well as findings from a study conducted around the use of the assessment. Our qualitative and psychometric findings reflect challenges faced by researchers as they develop early childhood assessment tasks for CT. We will share ideas for item formats that work well for making claims about young children's CT learning.

Assessing Student Learning in Open-Ended STEM+C Learning Environments

Integrating STEM and CT through a progression of model building activities provides productive avenues for engaging and assessing students' CT processes that support inquiry and problem solving. We have developed rubrics to assess and score students' progressions from conceptual (e.g., applying scientific laws to a specific problem) to computational modeling (building and debugging computational models in a block-structured environment). Our summative pre-post assignments, split into science and CT components, align well with published standards. We will discuss how the student progressions help guide teachers' instructional activities and scaffold students when they have difficulties integrating STEM and CT concepts during model building tasks.

Game-Embedded Assessments of Computational Thinking

Our work focuses on embedding assessment opportunities within a game-based platform to allow students to demonstrate learning and mastery of CT knowledge, skills, and abilities (KSA). Our project began by documenting the progression of KSAs that reflect CT competencies for middle school students. We then aligned these KSAs with game design elements of an operational game, Minecraft. To allow students and teachers to interact with the CT concepts in authentic ways that promote fluid gameplay, we developed an online companion application that allows students to model their solutions using graphical displays. Teachers use a learning management system to monitor students' learning and mastery of CT concepts.

Measuring College-Ready Computational Thinking

We are developing learning progressions, construct maps, and both open-ended and forced choice items that measure CT, for use in a test of college-ready critical reasoning skills. Our constructs include conceptualizing a problem, designing computational solutions, implementing computational solutions, and analyzing, evaluating, and iterating computational solutions. We have integrated our existing items into an existing online assessment system and are currently gathering pilot test data, as well as generating additional items. We will discuss the ways in which these assessments are useful both formatively and summatively for teachers and students in high-school mathematics classes and introductory computer science courses.

These projects highlight variations in how CT is operationalized and measured across K-12. We will present innovative methods for assessing students CT skills including assessment tasks, game-based learning, rubrics, and open-ended items. This session will include a discussion of next steps and future directions for the area of CT assessment.

References

Wing, J. M. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33-35.
Grover, S., & Pea, R. (2013). Computational thinking in K—12: A review of the state the field. *Educational Researcher, 42*(1), 38–43.