Collaborative, Computational STEM Learning Environment

C2STEM Highlights

- Challenge-based, evidence-centered design of STEM curricula to meet NGSS & state science standards
- Low threshold, wide-belly, high ceiling: unaccompanied using domain-specific block-structured languages to support learning progress
- Coupled multi-level representations to support learning: conceptual modeling & inquiry components offer new forms of exploring & decomposing STEM domain
- Synthetic learning: emphasis on integrating CT with existing science curricula – complements CS4All programs
- Simultaneous assessments for STEM & CT – Utilize ECD & PFL assessments for learning performance and behaviors
- Collaborative model building to support interaction & promote collaborative skills
- Involve teachers in curriculum development and support for classroom activities

C2STEM Instructional Design

High school Physics Honors Kinematics + Mechanics Learning by Modeling – learn Physics by building simulation models of physical processes (e.g., movement of objects)
- Step by step modeling approach (introduce students to concept of simulation step; relations expressed in Δt increments)
- Creates synergistic learning opportunities

Evidence-Centered Design (ECD) applied to developing curricular modules and embedded assessments
- Align with NGSS standards and classroom curricula
- Create effective synergistic learning opportunities through embedded assessments

Preparation for Future Learning (PFL) assessments to study transfer of learning

Classroom Studies

Preliminary results from studies in high school Physics classrooms in Nashville, Tennessee.

Multiple Analyses
- Pre-Post, Embedded Assessments, Video Analyses, PFL Assessments

Pre-Post Kinematics + CT Results, Classroom Study

Assessment Design and Problem Decomposition

Computational Modeling
- Key to synergistic learning of STEM + CT
- Uses coupled representations
- Conceptual Modeling used to frame computational modeling problems
- Computational model constructed from domain-specific blocks
- Model execution structure
- Initialization block + Run block
- Step-by-step model (simulation step, Δt)
- Visualize model execution
- Animation, inspecting variable values, generating plots

Synergistic Learning Tools

Domain -Specific STEM Programming Blocks provide the grounding for Synergistic Learning

Conceptual Modeling supports
Computational Modeling: enables Planning, Problem Formulation, and Problem Decomposition

Enhancing Inquiry

From racing sloths to conducting experiments on the effects of gravity, we have added unique inquiry tools for engaging and motivating STEM learning.

Prior to building their own simulations, students can run tests, use scientific tools (e.g., our graphing component), and compare results with expert model code to inspire powerful ideas!

Collaborative Problem Solving

Model Building and Problem solving in groups of two or three
- Students share workspace
- Create shared representations (models) and shared understanding
- Socially shared-regulation supports task understanding, planning, strategy use, monitoring, overcoming difficulties, and collaboration

PFL Assessments

- Preparation for Future Learning (PFL) assessments provide opportunities to learn during the assessment
- PFL measures focus on students’ ability and propensity to apply computational constructs and CT practices while learning new STEM topics within and outside of kinematics.
- Exemplar targets the kinematics concept of jerk

Example task and rubric addressing the integrated learning goal: Develop a computational model that simulates 1-D, constant velocity motion using addition of velocity vectors that exist only under particular conditions.

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