Vectors of CT-ification: Integrating Computational Activities in STEM Classrooms

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ABSTRACT

While the Next Generation Science Standards set an expectation for developing computer science and computational thinking (CT) practices in the context of science subjects, it is an open question as to how to create curriculum and assessments that develop and measure these practices. In this poster, we show one possible solution to this problem: to introduce students to computer science through infusing computational thinking practices ("CT-ifying") science classrooms. To address this gap, our group has worked to explicitly characterize core CT-STEM practices as specific learning objectives and we use these to guide our development of science curriculum and assessments. However, having these learning objectives in mind is not enough to actually create activities that engage students in CT practices. We have developed along with science teachers, a strategy of examining a teacher's existing curricula and identifying potential activities and concepts to "CT-ify", rather than creating entirely new curricula from scratch by using the concept of scale as an "attack vector" to design science units that integrate computational thinking practices into traditional science curricula. We demonstrate how we conceptualize four different versions of scale in science, 1. Time, 2. Size, 3. Number, and 4. Repeatability. We also present examples of these concepts in traditional high school science curricula that hundreds of students in a large urban US school district have used.

CCS CONCEPTS

• Social and professional topics → Computational thinking; **K-12 education**; **• Applied computing → Education**.

KEYWORDS

computational thinking, science education, agent-based modeling

1 THE CT-STEM PROJECT

The CT-STEM Project at Northwestern aims to integrate computational thinking practices in order to achieve three goals: 1. To broaden participation in computing; 2. To provide a more authentic scientific experience; and 3. To deepen scientific content knowledge. Teaching CT in the context of science presents students with a more authentic image of science as it is practiced today, and also increases access to powerful modes of thinking and marketable skills for many careers [1]. The CT-STEM Project aims to improve access for all students, especially those underrepresented in CS, by embedding CT practices in subjects such as biology, chemistry, and physics, which all high school students are expected to take anyway. While this does not ensure that students will be personally motivated to engage in our curriculum, it does ensure that they will be given the opportunity to develop CT practices.

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2 CREATING A FRAMEWORK TO IDENTIFY OPPORTUNITIES FOR CT-IFICATION

A logical question then becomes, how do we achieve this goal? Researchers worked with teachers in a research-practice partnership that began with a four week summer professional development program in order to develop "CT-ified" science curricula for their classroom. However, both the teachers and the researchers struggled to find a framework by which to identify parts of the science curricula that might be fruitful to "CT-ify." In this poster, we present the initial stages of a design framework for identifying and designing computational activities that deeply engage students in both scientific content and computational thinking practices.

Specifically, we focus on leveraging the scientific concept of 'scale' (which we conceptualize in four different ways: 1. Time, 2. Size, 3. Number, and 4. Repeatability) to engage students in computational modeling and computational data practices [4]. Our poster and associated demos will show examples of activities and curricula across High School Biology, Chemistry, and Physics co-developed by teachers and educational/computational researchers across these four dimensions of scale using various computational tools including NetLogo [5], NetTango [3], CODAP [2], and Google Sheets. Our early efforts show that High School STEM teachers are able to identify these opportunities to integrate CT into their classroom and see these activities as opportunities for students to engage deeply with both science and computation simultaneously.

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