Computer Science Unplugged

Overview

One of the most engaging ways to expose students to computer science concepts or to develop computational thinking skills is to implement an "unplugged" lesson. These types of lessons do not involve students directly interacting with computing devices, rather they enable students to conceptualize the way a computer would solve a given problem or perform a given task. Unplugged lessons are powerful metaphorical tools to bridge the gap between students' lived experiences and unfamiliar ideas related to computing.

Contexts

Bell, et al. (2009) state that students "generally know the computer as a tool or toy, rather than the subject or study in itself. By stepping away from the computer they are able to think about issues that Computer Scientists face beyond simply programming." They note that children often find these problems and solution algorithms to be fascinating, so removing the expectation of first learning to program effectively removes a barrier to their inspiration and appreciation of the true challenges and opportunities of the CS field.

Unplugged lessons were initially intended for outreach - that is, recruiting students to computer science programs. Indeed, cognitively challenging tasks such as card games, or engineering activities like boat- or bridge-building - all of which can easily be made to have a competitive element - are engaging and fun ways to "hook" students. However, the lessons are also effective for legitimate computer science learning at all levels of education, from Kindergarten through at least 12th grade. The often multisensory and social nature of unplugged activities makes them ideal for all students. It is recommended to incorporate unplugged lessons whenever possible to introduce, reinforce, and/or assess a new topic.

Example

An example of an unplugged activity that I have enjoyed teaching, and that my students have enjoyed participating in, is called "Conditionals With Cards." The activity was developed as part of Code.org's Computer Science Fundamentals curriculum, and is designed to teach students about the conditional control structure, or selection statements. The introductory video shown to students makes use of metaphor and abstraction to help students understand the concept of choosing between two or more options based on a given rule or set of rules. Students are asked to play a game (and develop one of their own) in which they and their opponent draw playing cards from a deck at random. Depending on the given rule (if the card is red), one of the individuals will receive a point. Performing this one activity with my 3rd grade students this year enabled the class to accurately conceptualize compound if-else statements in the context of a game. When we applied the concepts to programming problems, the transfer was less of a challenge than I have experienced in previous courses.

Suggestions

- Incorporate at least one unplugged lesson for every new programming or problem-solving concept encountered in the course.
- Throughout a course, students should experience a diversity of unplugged lessons

- ones that involve making/building/doing, algorithm development, games, discussion, planning, reflection, multiple answers/approaches, creativity/artistry, cooperation/collaboration, etc.
- Ensure that unplugged lessons provide equal opportunities for all genders and ethnicities to engage with new ideas and express their own while not invoking stereotype threat.
- Unplugged lesson plans are often much longer than programming lesson plans. Familiarize yourself with the lesson plan and practice the activities yourself, so that your facilitation of the activity becomes natural.
- Plan ahead and gather enough materials (low-cost) for the entire class.

Evidence

Lambert & Giuffre (2009) conducted a series of unplugged activities as part of an outreach program at the elementary level in Virginia. The activities included "Representing Numbers, Text, Sounds and Images" (using basic binary concepts), "the magic parity trick" to simulate TCP, and a non-computing unplugged activity practicing fractions and long division. Their results indicated that after the activities, students were "more interested in computer science, had significantly higher cognitive competence, and were significantly more confident about math…" They also noted that students received the interventions enthusiastically, and many were proud to come away with things they could take home to show their parents. Rodriguez's (2015) extensive research concluded that unplugged activities improved students' computational thinking skills, and that "Students demonstrated mastery of at least one problem domain from each CS Unplugged activity they completed" (54).

References

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