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Computer Science for All with Spreadsheet Modeling: Researching How Low-Cost Video Training for STEM Teachers Leads to High-Value Programming Skills for Students.

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Abstract for the 116th Congress of the United States of America:

This SBIR Phase 1 Project will seek to solve the problem of how to incorporate new and standardized approach to computer science instructional modeling experiences for students using a combination of video training, instructional materials, and assessment materials that can be accessed by teachers from an online platform to which teachers can contribute newly developed ideas for authorship credit and compensation. Models that simulate realistic behavior are usually inherently complex using mathematics such as calculus or differential equations. As a result, many teachers do not recognize the many possible ways that these models can be developed on spreadsheet programs. While teachers and students already can access and have baseline familiarity with spreadsheets, there exists many new computational modeling applications that can fundamentally change the nature of the way students learn Science, Technology, Engineering and Math (STEM) as separate subjects by unifying them into one instructional modeling experience. This study will develop and investigate methods of training inexperienced teachers in computational spreadsheet modeling that are designed to enable easy to follow pathways for teachers to deliver spreadsheet modeling experiences to their students with in-person training or having to develop and test their own student experiences. This will serve to expand the use of computer science in classrooms in compliance with the Next Generation Science Standards (NGSS) and open up the realistic modeling capability intrinsic to calculus and differential equations, to high school students while using exclusively algebraic equations.

This proposal will seek to develop, adapt, and assess the effectiveness of an inexpensive video-based demonstration and teacher training regimen that is intended to make delivering this instructional methodology to students happen quickly, efficiently and become self-sourcing by teachers from many different schools. This will be done by automating the training to keep cost to a minimum and maximize teacher time savings and the value added of the modern microprocessor to the student instructional experience of computational modeling on a spreadsheet. For a typical spreadsheet modeling objective, students follow procedures employing numerical methods (such as slope of lines, areas of trapezoids, difference equations, Euler's Method) incrementally over large numbers of cells (10^2-10^4) to build a realistic mathematical model on a spreadsheet. By doing this, the error associated with the numerical approach drops well below the error associated with model assumptions making it possible to model non-ideal continually changing variables with linearized assumptions. The computational power of the spreadsheet enables instantaneous replication of the linearized formulas, which when patterned properly with fixed and relative references, can produce pivot tables in which variables can be altered by students using inquiry and curiosity to investigate a model that they programed starting from a blank spreadsheet. By building off of a variety of curriculum aligned applications and crafting the instructional experience using a carefully tested pedagogy, teachers will be provided with high value skills to pass on to their students so they will be able to first program, then simulate, experiment and solve problems on a variety of new quantitative spreadsheet modeling scenarios in STEM classes.

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