Georgia Race to the Top
Innovation Fund
Application Face Sheet

SECTION 1: APPLICANT AGENCY

Applicant Agency (Legal Name): Georgia Tech Research Corporation

Legal Mailing Address: 505 Tenth Street NW

City: Atlanta County: USA State: GA Zip: 30332-0002

Federal Employer I.D. #: 58-0603146 DUNS #: 09-7394084

Congressional District #: Fifth

Executive Officer Name: Christopher D'Urbano Title: Division Manager

Street Address: 505 Tenth Street NW City: Atlanta State: GA Zip: 30332-0002

Telephone: 404-385-6797 FAX: 404-385-0864 Email: christopher.durbano@osp.gatech.edu

SECTION 2: PARTNERSHIP LEAD CONTACT

Contact Name: Michael Schatz Title: Professor

Street Address: 837 State Street

City: Atlanta State: Georgia Zip: 30332-0430

Telephone: 404-894-5245 FAX: 404-385-2667 Email: Michael.schatz@physics.gatech.edu

SECTION 3: FISCAL CONTACT

Contact Name: Christopher D'Urbano Title: Division Manager

Street Address: 505 Tenth Street NW

City: Atlanta State: GA Zip: 30332-0002

Telephone: 404-385-6797 FAX: 404-385-0864 Email: christopher.durbano@osp.gatech.edu

SECTION 4: PROJECT INFORMATION

Project Name: **Computational Thinking: 21st Century STEM Problem-Solving Practices for Georgia Students**

Partner Names: B.E. Mays High School, Tapjoy, Inc.

Priorit(ies) Addressed: 5

Grant Amount Requested: **$431,198**

SECTION 5: PARTICIPANT DATA:

Approximate number of students served: (Initial 2 years, 240; later, potentially many more)

Population of focus (i.e. age, gender, race): High School Students (age 14-18), both genders, all races

SECTION 6: SERVICE DELIVERY AREA

Primary county or counties to be served: Fulton

List other counties to be served (if any): (Any Georgia county with RT3 schools (depends on teacher recruitment for Year 2 Workshop)

Congressional District(s) to be served: 5 initially, potentially others.

SECTION 7: PROGRAM ACTIVITIES

1. Development/Testing/Implementation of Computational Thinking Curricular Materials for High School Physics courses.
2. Workshops/Online Community Building for teacher training and support for Modeling Instruction methodologies and Computation Thinking.

SECTION 8: APPLICANT AGENCY FISCAL INFORMATION

1. Month of Fiscal Year End: June
2. Attach to the application, the applicant agency's financial audit.
3. Is applicant agency delinquent on any federal debt? NO☒ YES☐ If yes, attach a detailed explanation.
4. Did applicant agency receive 80 percent or more of its annual gross revenue in federal awards in its preceding fiscal year; and $25,000,000 or more in annual gross revenue from federal awards and in so doing is required to comply with "Federal Funding Accountability and Transparency Act"? NO☐ YES☒ If yes, attach names and total compensation of the five most highly compensated officers of the grantee.

   *Per ARRA requirements, compensation information is publicly available through reporting to the SEC and therefore not required to be listed. https://www.fsrs.gov/#a-faqs

SECTION 9: AUTHORIZING SIGNATURES

I, the undersigned, an authorized representative of the applicant, have read, understand, and agree to all relative conditions specified in the Race to the Top Innovation Fund Request for Proposals and having read all attachments thereto do submit this application on behalf of the applicant agency. If awarded a grant to implement the provision herein, I do certify that all applicable federal and state laws, rules, and regulations thereto will be followed.

APPLICANT AGENCY:

[signature] Division Mgr 7/10/12

Signature and Title Date

Computational Thinking: 21st Century STEM Problem-Solving Practices for Georgia Students

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EXECUTIVE SUMMARY

Computational Thinking: 21st Century STEM

Problem-Solving Practices for Georgia Students

(in collaboration with **Google**)

Partners: **Georgia Tech School of Physics** (Lead Partner); **Benjamin E. Mays High School** (an APS High School); **Tapjoy, Inc.** (a Silicon-Valley technology company with an Atlanta branch)

Target Population: **Georgia High School Students**

Geographic Location: **(Initially) Atlanta-area; (Ultimately) any Georgia High School.**

Number of Individuals Served: **(Initially) 300 students, 22 teachers of physics/physical science; (Ultimately) many more Georgia students and teachers.**

Twenty-six states (including Georgia) are now helping to forge **Next Generation Science Standards**, which **include essential practices** [Reference 1] for addressing modern, real-world challenges that involve science, technology, engineering and mathematics (STEM). The K-12 Framework [Reference 2], the foundation for Next Generation Science Standards, emphasizes that the **integration of practices with other dimensions** (core ideas and crosscutting concepts) to develop and to produce new curricula and instruction **"is an area ripe for research and innovation"** [Reference 3]. ***We propose a pilot project*** (addressing Priority 5) ***that aims to put Georgia at the national forefront for STEM curricular reform for Next Generation Science Standards. With a systematic approach, we will incorporate into high school STEM curricula two critical scientific practices which are currently not taught in Georgia schools: Computational Thinking and Developing & Using Models*** [Reference 4]**.**

There is a particularly urgent need to nurture the practice of Computational Thinking (CT), in which computer algorithms are constructed to simulate, to visualize and to solve real-world problems. Computation (the application of CT) is a cornerstone of modern science and engineering, equal in importance to theory and experiment. By contrast, the underlying Computational Thinking needed for computation is ignored by virtually all high school STEM course curricula in Georgia (and across the nation). The usual sort of computer usage widespread in many STEM courses (e.g., accessing learning materials or acquiring lab data) does NOT teach CT because this usage has not fundamentally changed the artificial nature of most "school math" and "school science" content: a decades-old focus on end-of-chapter exercises, dumbed down (by comparison to real-world problems) to limited, special-case situations. Historically, this practice of simplifying physics problems was necessary to enable solutions to be calculated by hand (with, at most, the assistance of a calculator). Thus, it should come as no surprise that many Georgia (and U.S.) students emerge from high school ill-prepared as cyberlearners, i.e., such students lack crucial experience in using the skills of CT that they need, both as members of the workforce and as members of society, to deal with the major, often highly technical, challenges of the 21st century. (For a general overview of this nationwide problem in the context of math, see http://www.ted.com/talks/conrad_wolfram_teaching_kids_real_math_with_computers.html)

We propose to integrate CT into a widely-acclaimed national STEM teaching reform, the Modeling Instruction methodology [Reference 5]. Modeling Instruction, which emphasizes the practice of Building and Using Models, does not typically include CT. ***Our proposed blending of Computational Thinking with a proven method for Building & Using Models is novel and cutting-edge; this synergistic combination will provide Georgia students extensive exposure to these two key STEM practices in ways that go beyond any other high school STEM curriculum in the nation.*** In this pilot project (addressing Priority 5), the development and implementation of curricular materials will **focus on integrating these practices with** discipline-specific content in **Physical Science Core Component Idea PS2.A: Forces and Motion, listed in the K-12 Framework for Next Generation Science Standards** [Reference 10]; however, we expect the methods developed here will be directly transferrable to Core Ideas in the Physical, Life, and Earth & Space sciences as well. Additionally, with our corporate partner, Tapjoy, Inc., we will provide students real-world opportunities to use CT skills by hosting Mock Interviews at partner schools, whereby students will be challenged to solve CT-based interview questions that are inspired by CT-based questions used by a number of high-tech companies like Tapjoy during real-world job interviews. Moreover, we will offer teacher training workshops to be held on the Georgia Tech (GT) campus; the workshops will provide training both in Modeling Instruction methodologies for physical science/physics and in CT methods that can be applied in the context of the Modeling Instruction program. Continuing education on CT will be offered via web-based delivery (e.g., Elluminate collaborations hosted by GT); moreover, a online presence (hosted at Google's Exploring Computational Thinking website) will fostered to grow and to sustain a community of STEM instructors across Georgia who incorporate CT work as a key part of their course curricula.

Section 1. Partnership Overview

A **partnership** of **Georgia IHE, a Georgia (RT3) high school, and a Silicon Valley technology company (with an Atlanta-based office)** in collaboration with **Google** is committed to bringing 21st century STEM practices of **Computational Thinking** and **Building & Constructing Models** to Georgia students. By many measures (see **Section 2**), the performance of Georgia students in STEM lags behind that of students in other states. This partnership is not willing to settle for simply playing "catch up"; the partnership shares a **radically transformative vision** that **Georgia students** can **"leapfrog" STEM performance elsewhere in the nation**. At the same time, this partnership believes that a solid grounding of CT and Building/Constructing Models embedded in STEM courses can substantially lower the barriers to tackling diverse, interesting, and challenging real-world problems involving substantial STEM content, thereby **increasing access for significantly more Georgia students to rigorous STEM content.**

Google is, in effect, a "de facto" partner of the proposed effort, by virtue of the significant support that **Google** is providing (see **Google's Letter of Support** in the Appendix), even though it is not a signatory of the partnership MOU. **The proposed work represents a golden opportunity for Georgia K-12 schools to foster a close working relationship with one of the world's premier technology companies.** Google has initiated and committed resources to efforts that promote, explore, and develop K-12 student learning of Computational Thinking. Google will play a central role in dissemination and sustainability by hosting a highly visible forum for curricular materials developed under this proposal in two distinct ways: (1) Via links to Google's discussion boards (http://services.google.com/edu/computational-thinking/forum-toc.html), (2) Through Google's Exploring Computational Thinking (ECT) database (http://www.google.com/edu/computational-thinking/lessons.html). Finally, Google will provide, appropriate curricular materials developed in-house at Google for the partnership's evaluation and use as those materials become publically available.

The Benjamin E. Mays High School (an Atlanta Public Schools (APS) High School) has a magnet program of Science and Mathematics designed to draw students from across the Atlanta area. Two of the science faculty at Mays, **Aruna Kailasa and Sheela Caesar,** bring prior experience with the Modeling Instruction methodology, which provides a key element for our proposed work (see **Section 3**). Thus, Mays science classrooms provide an ideal environment for initial implementation and testing of new materials; moreover, the Mays team will help facilitate dissemination to other RT3 schools.

Tapjoy, Inc. (a Silicon Valley high technology company with an Atlanta-based office) provides alternative payments services for mobile app users that are mutually beneficial to both app users and app makers. Since Tapjoy's 2007 founding, more than 500 million app users have interacted with Tapjoy's mobile services. Tapjoy's employees frequently use the practices of Computational Thinking and Building/Developing Models in their work; as a result, **Brian Stebar II**, co-founder of the Atlanta branch of Tapjoy, employs tests of CT in interviews with prospective employees. Mr. Stebar and Tapjoy will share real-world CT experiences with students via the Mock Interview process described below.

Georgia Tech (a Georgia IHE) is one of the world's leading universities with world-class programs in numerous STEM disciplines. **Michael Schatz,** the Principal Investigator (PI) and a member of the Georgia Tech Physics faculty**, has extensive experience implementing large, complex, and rapidly growing projects,** including **eight different projects** with grant support for scientific research in fluid dynamics and physics education totaling over $2 million from the National Science Foundation [Reference 6]. More specifically, Professor Schatz has extensive experience in the implementation of projects focused on improving the teaching and learning of physics/physical science [References 7 and 8], ***including Computational Thinking and Building/Using Models***, that have led to positive student outcomes. From 2006 to 2010, the PI was a co- leader for a multi-million dollar, multi-university (Georgia Tech ($400,000), Purdue University ($600,000), Carnegie-Mellon University, and North Carolina State University ($1,000,000, split between CMU and NC State)) NSF-sponsored project (DUE-0618159, DUE-0618504, DUE-0618647) that implemented a reform introductory physics curriculum (called *Matter and Interactions* or *M&I*) focusing on teaching Computational Thinking and fundamental principles (presented in a reorganized way suggested by cognitive science). At present, each year over one thousand Georgia Tech undergraduates take introductory physics using the reform curriculum including Computational Thinking; furthermore, ten GT academic faculty (more than 25% of the GT Physics faculty) have been trained to teach the reform curriculum. The reform curriculum has demonstrated positive outcomes; specifically, students at four universities taking the reform curriculum outscored students on a nationally-accepted concept inventory for electricity and magnetism, a result that has been reported in the peer-reviewed literature [Reference 7]. The effort with Computational Thinking plus Building/Using Models in Physics is continuing at Georgia Tech; the PI is currently conducting NSF-sponsored research (DUE-0942076) that is developing advanced Computational Thinking exercises for students in university physics. This work forms the `basis for the development and implementation of these key STEM practices in the K-12 setting that is proposed here.

Section 2. Need for Project

Two clear and urgent needs of Georgia STEM education drive the project we propose:

1. **The need to overcome achievement gaps on national standardized assessments: Georgia students lag behind the nation and Atlanta students lag behind other Georgia students.**
2. **The need for curricula that integrates scientific practices with content: The heart of Next Generation Science Standards, which Georgia is helping to develop** [Reference 2], is Practices integrated with Core Ideas; however, **no curricular materials currently exist anywhere in the nation to do this for Building & Using Models and Computational Thinking.**

Below we describe these needs in more detail, including, where appropriate, an emphasis on the educational needs of the target population of Atlanta-area and Georgia high school students in STEM.

NEED 1: Bridging Georgia and Atlanta-area STEM Achievement Gap

For years, Georgia students have ranked near the bottom of the nation in average SAT Math scores; the most recent data shows no change to that trend. **In 2011, Georgia ranked 49th out of 50 states in average SAT math scores.** [Reference 9] States (like Georgia) with high student participation rates for the SAT exams will tend to have lower average SAT scores; however, adjusting for participation rate does not help matters for Georgia. **In 2011, Georgia's average SAT math score was 17th out of 18 states with high participation rates.** [Reference 9] As one example, when comparing Georgia (80 % participation rate in SAT) with Massachusetts (89% participation rate), one finds Georgia's average SAT Math score (487) was 40 points below that of Massachusetts (527).

The situation is worse for some Atlanta area students. We illustrate this with data from our partner high school (Mays High School); **we emphasize that other Atlanta-area schools have results that are similar to the data from Mays.** In 2008, the average SAT Math score for Georgia was 493 (similar to the 2011 score and also near the bottom nationally); the average SAT Math score at Mays was substantially worse (461). In percentile terms, this average SAT math score placed Mays students who took the SAT in the bottom 33% of students nationally. Data from the 2008 ACT exams tell a similar story; close examination of the percentage of ACT test takers at Mays who were considered college-ready in math and science (i.e., the percentage of students who met or exceeded the "college readiness" benchmark scores—ACT score 22 for mathematics and 24 for science) indicates that, in 2008, only 15% of Mays students who took the ACT were college ready in math (vs.38% for Georgia and 43% nationally) and only 9% of Mays students were college-ready in science (vs.23% for Georgia and 28% nationally).

NEED 2: Integrating Scientific Practices into Georgia and Atlanta-area STEM curricula

The **K-12 Framework**, which serves as **the foundation for the Next Generation Science Standards**, articulates a fundamental weakness with science education in Georgia and across the nation: "[the failure to] provide students with engaging opportunities to experience how science is actually done." [Reference 2] The Framework affirms the idea that "every science unit" communicate a disciplinary core idea; the Framework also **emphasizes** that "**A major question [confronted by] each curriculum developer will be [how to] feature in lessons or units the practices…..around a particular disciplinary core idea**…" [Reference 2] Additionally, the Frameworks states: "**…** the curriculum should provide repeated opportunities…for students to develop their facility with these practices and use them as a support for developing deep understanding of the concepts in question and of the nature of science and of engineering. ***This will require substantial redesign of current and future curricula***." [Reference 2] Our proposed work is directly aimed to address these issues.

Section 3. Quality of Project Design

We propose a pilot project (addressing Priority 5) with an out-of-the-box idea new to Georgia and the nation: ***blending a proven method for teaching the scientific practice of Building & Using Models with cutting-edge curricular materials that teach the practice of Computational Thinking. This synergistic combination will provide Georgia students extensive exposure to these two key STEM practices in ways that go beyond any other high school STEM curriculum in the nation.*** Modeling Instruction, a widely-acclaimed national STEM teaching reform [Reference 5], emphasizes Building and Using Models but does not include instruction on Computational Thinking. In this project, the development and implementation of curricular materials will **focus on integrating these practices with** discipline-specific content in **Physical Science Core Component Idea PS2.A: Forces and Motion, listed in the K-12 Framework for Next Generation Science Standards** [Reference 10]; however, we expect the methods developed here will be directly transferrable to Core Ideas in the Physical, Life, and Earth & Space sciences as well. With our corporate partner, Tapjoy, Inc., we will also provide students real-world opportunities to use CT skills; specifically, by hosting Mock Interviews at partner schools, whereby, students will be challenged to solve CT-based interview questions that are inspired by CT-based questions used by a number of high tech companies like Tapjoy during real-world job interviews. We expect that our proposed approach will help equip Georgia students for radically transformative learning experiences with intensive exposure to heightened, challenging academic rigor (well beyond what is possible in current STEM curricula) and ultimately help them develop stronger real-world problem-solving skills.

Below, we describe how we plan to achieve this ambitious program. We first describe what Computational Thinking is and why it is important **(Section 3.1)** before we discuss the details of our methodology (**Section 3.2**) and implementation (**Section 3.3**) with two major goals in mind: **Goal 1:** ***Classroom development, testing and implementation of curricular materials for Physics (Physical Science Core Component PS2.A) in Georgia High Schools*** and **Goal 2:** ***Fostering a sustainable community of Georgia teachers with expertise in the practices of Building & Construction Models integrated with Computational Thinking in High School STEM.***

3.1 How Computational Thinking revolutionizes STEM education---the example of physics.

Computational Thinking pervades all STEM disciplines in the real world; physics provides a good starting point for infusing CT into K-12 education. Physics is fundamental; key ideas in all other physical sciences (e.g., chemistry), life sciences, and earth & space sciences are often founded on physics principles. Additionally, mathematics is commonly used to describe ideas in physics. Thus, successful development and implementation of CT in physics provides a solid foundation for developing and implementing CT in other STEM disciplines.

Within mechanics, the physics of how things move, the topic of Force and Motion (Physical Science Core Component PS2.A in the Framework for K-12 Next Generation Science Standards [Reference 10]) is typically the first important theme encountered by students in high school physics. A major goal of the study of Force and Motion is to "predict the future", i.e., to predict the motion of object(s), starting from key ideas and initial information. The main approach to predicting motion can be simply described in only a few words. To start, one needs to know (a) where the object is (the current position), (b) how the object is moving (the current velocity), and (c) one property of the object (the object's mass). With this information, we can then predict the object's new velocity a short time later by using Newton's 2nd Law (*force equals mass times acceleration*); this new velocity can then, in turn, be used to predict the object's new position a short time later. If we want to predict the motion still further into the future, we simply repeat this process over and over. **One semester of high school physics has been summarized in one paragraph; this description captures the essence of how professional scientists and engineers solve many real world problems involving motion prediction.**

Now, it's well-known the word "physics" often strikes fear and loathing into the hearts of many students (and ex-students). Yet, the main physics of motion prediction, as summarized above, isn't all that scary or hard to understand. Clearly, certain concepts (e.g., velocity, mass) must be mastered; however, the chief difficulties that physics students encounter are not with the physics ideas themselves. Rather, the students' struggles primarily reside in understanding the processes of calculation needed to translate the physics ideas and concepts into actual predictions. Before we see how CT can dramatically help students, we first look briefly at why students often find the calculations of physics so troublesome.

3.1.a The current reality: Students fear Physics Problems. Typical high school physics courses place an **over-emphasis on ONE way** to use physics ideas **for problem solving**: **Manipulating mathematical equations using pencil and paper methods (analytic methods).** For example, to predict motion, students in typical physics classes apply pencil and paper methods using the equations

$$v = v_0 + at; x = x_0 + v_0 t + \frac{1}{2}at^2; v^2 = x_0 + v_0 t + \frac{1}{2}at^2$$

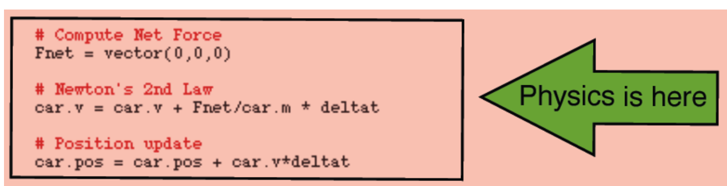
to solve end-of-chapter homework problems or test problems. Even with the assistance of a calculator, learning to solve physics problems proficiently with pencil and paper methods is difficult and requires lots of practice. Requiring students to put in significant effort is always necessary for a good educational experience; however, **an over-emphasis on manipulating equations using pencil and paper methods leads to excessive and unnecessary hard work that not only discourages students, but also teaches bad problem solving habits.** In particular,

(1) Most real-world problems are too hard for high school students (and many professional physicists!) to solve using pencil-and-paper methods. Thus, high school physics often focuses on a small number of boring, artificial problems (e.g., balls rolling down inclined planes), with a narrow scope disconnected from reality This difficulty leads to:

(2) Poor student problem solving due to excessive focus on formulas. When general physics principles are applied to a narrow range of problems, specialized sets of equations can be derived to solve such problems. Unfortunately, when they are drilled only on such special cases, students focus excessively on finding and manipulating such specialized equations or "formulas"; as a result, the students become fragile problem solvers who cannot recognize when circumstances require revisiting key principles from the start because specialized formulas fail to apply.

In essence, the exclusive focus on manipulating equations using pencil-and-paper methods dates back to the time before the invention of the computer when there was no other way to solve physics problems. Decades ago, professional scientists and engineers stopped relying solely on pencil/paper methods for physics problem solving and developed the practice of Computational Thinking. It's time for high school physics students to do the same.

3.1.b The vision: Physics Problems now fear Students (who use Computational Thinking). Using the tools of Computational Thinking, we can express key ideas in physics in powerful ways. For example, the fundamental ideas of motion prediction can be expressed using CT as:



In length, the CT approach to motion prediction is not much different from the specialized equations for pencil/paper methods shown earlier. However, in this CT form, there are several enormous advantages:

(1) Motion prediction of any system here is directly connected to the fundamental description of that system (given verbally in **Section 3.1**). We see directly here the use of Newton's 2nd Law to predict a new velocity, then the use of the new velocity to predict the new position. Because the general principle is expressed directly,

(2) the specific CT example given here is suitable for the special case of a specific object (here, a car). However, *with small changes,* this same code can be used to attack real-world problems that are far more sophisticated than is possible with pencil-and-paper methods.

(3) Solving the problem with CT allows for a dynamic computer visualization of the physics of motion that can occur simultaneously with quantitative calculations.

(4) Experience with the programming language used here (Python, which is accessible to high-school students), is a practical real-world job skill widely used by practicing scientists and engineers.

With CT skills in hand, high school students can solve real-world problems. For example, a student might be interested in using CT to model how drag forces (and, therefore, fuel mileage) can differ between different vehicles. Yet another student might see a YouTube video of motion that is hard to believe (e.g., a video of someone throwing a ball from the upper deck of an arena and sinking a basket); that student could use CT as a "Mythbuster" to determine whether the video was real or fake. The bottom line here is that CT gives students the ability to tackle and to solve challenging real-world problems in ways that would not be possible if the same students were exposed only to current STEM curricula. We don't claim that this will be easy: using CT to solve problems will require significant effort from students. However, it's clear that the long term payoff is substantial.

3.2 Methodology: Blending Two Key Practices into High School Physics We propose to integrate CT within a widely-used reform STEM methodology—the Modeling Instruction program that teaches the practice of Building and Constructing Models.

3.2.a Modeling Instruction---a research-based reform STEM curriculum design [Reference 5]. The Modeling Instruction Program for STEM teaching, developed at Arizona State University, provides teachers with a robust teaching methodology for developing student abilities to Build and Use Models in a variety of STEM contexts. In brief, Modeling Instruction is organized into modeling cycles that engage students in model development, evaluation, and application in concrete situations—thus promoting an integrated understanding of modeling processes and the acquisition of modeling skills. Each cycle begins with a demonstration and class discussion to establish common understanding of a scientific question. Students then collaborate in planning and conducting experiments to answer or clarify the question. Students present and justify their conclusions in oral and/or written form, including a formulation of models for the phenomena in question and evaluation of the models by comparison with data.

Modeling Instruction is widely used and has proven very effective. Over half the physics teachers in Arizona and thousands of science teachers nationwide (including teachers of chemistry, physical science, and biology as well as physics) have received extensive professional development in Modeling Instruction. The effectiveness of Modeling Instruction has been evaluated with well-established standardized instruments, chief among them being the *Force Concept Inventory* (FCI). FCI data for more than 20,000 high school students reveal significant gains in understanding under Modeling Instruction. The Modeling Method has proven especially successful with students who have not traditionally done well in physics, while enhancing the overall performance of all students. Experienced modelers report increased enrollment, greater parental satisfaction, and enhanced achievement in college courses.

3.2.b How CT blends with Modeling Instruction. Modeling Instruction alone has beneficial effects; Modeling Instruction combined with Computational Thinking could have a **revolutionary impact.** Modeling Instruction emphasizes the practice of valuable model building skills, including the use of multiple representations and descriptions of a problem (e.g., graphical, oral/written prose, and mathematical equations); however, the scope of problems accessible to Modeling Instruction is limited, when only pencil/paper methods are emphasized for solving problems. Computational Thinking incorporated into Modeling Instruction provides students with a much broader array of practical modeling skills, providing new and dynamic ways to represent and to solve problems, thereby allowing students to think more creatively and more deeply about real-world problems.

3.3 Implementation. We propose a two-pronged approach to developing, implementing and sustaining instruction that integrates the practices of Computational Thinking and Building & Using Models into Georgia high school physics. First, we will revise the existing Modeling Instruction curriculum in physics (which is organized around modules) to integrate CT materials. The modules will be the starting point for CT thinking at all levels of high school physics and physical science; the modules will provide the foundation for advanced work in CT in AP courses. Second, we will develop and conduct teacher-traininga workshops and foster an online presence/community of instructors who are engaged with Computational Thinking blended with Building & Using Models with Modeling Instruction. Where approved by Google, dissemination of CT curricular materials will be organized around the online presence in CT provided by Google.

3.3.a* GOAL 1: *Classroom development, testing and implementation of Computational Thinking(CT) curricular materials for Physics in Georgia High Schools. Four fundamentally important Modeling Instruction Modules in High School Physics will be revised to blend in the practice of Computational Thinking with Building & Using Models:

1. Constant Velocity Particle Model (CVPM)
2. Balanced Force Particle Model (BFPM)
3. Constant Acceleration Particle Model (CAPM)
4. Unbalanced Force Particle Model (UBFM)

In preliminary work, we have already developed initial revisions and performed initial classroom testing (in 9^{th} grade physics classes at the Westminster Schools in Atlanta) of these modules; the associated drafts of these materials can already be accessed through the Google Exploring Computational thinking website (See [Reference 12]). Classroom testing of these modules at Mays will occur during AY 2012-2013; based on these tests, the modules will be revised and tested during AY 2013-2014, both at Mays and at other Georgia RTTT schools to be determined by the recruitment of additional physics/physical science instructors during Spring/Summer 2013 (see Section 3.3.b below). Final versions of the modules will be available for broad use in Georgia Schools (and elsewhere) by the start of AY 2014-2015; dissemination of the modules with CT materials will be organized through the Google ECT website.

Mock Interviews: Real-World Experiences with Scientific Practices for Students. As mentioned earlier, professional scientists and engineers utilize the practices of Computational Thinking and Building & Using Models to solve the real-world problems they confront every day in their working lives. As one consequence, technology companies (large and small) seek to hire employees with these abilities. To find such employees, technology companies commonly ask applicants, during job interviews, to evaluate test cases that require the usage of Computational Thinking and Modeling practices to find solutions. Under the guidance of Brian Stebar, who has had extensive experience using such interview methods for hiring employees at Tapjoy, Inc., we propose to conduct Mock Interviews, which incorporate these real-world interview methods, with students in the Computational Thinking/Modeling Instructions courses.

Once per academic year at each participating RTTT school, the Mock Interview process will proceed as follows: (1) A set of interview questions will be devised (focused on the students' experiences with CT/Building & Using Models in the context of Physics). (2) A practice Mock Interview will be held so students can gain some experience with the process and obtain feedback from interviewers, both on content knowledge and on ways to make a good impression during an interview. (3) A team of interviewers will come one day to the partner school and conduct interviews with each student in the participating courses. (4) Three finalists will be selected from the class; the interview team will visit a second time to conduct final interviews (total time for all interviews: 45 minutes), preferably in a general assembly setting where many students (not just those in the physics/physical science course) would attend and view the process. From these interviews, the finalists will be ranked and awarded prizes. Exhibiting the interview skills of the top students in a public setting would provide all students with some insight into the important elements required in a successful job interview.

We anticipate conducting one such Mock Interview process at Mays during AY2012-2013 and at additional participating RTTT schools (recruited as described below) during AY2013-2014.

3.3.b **GOAL 2:** ***Foster a sustainable community of Georgia teachers with expertise in Computational Thinking.*** In order to properly train the faculty using these new curricular materials, we propose creating an ambitious training workshop and ongoing professional development structure to support the faculty involved in this pilot project.

The core faculty at Mays will receive extensive training in the use of CT/Building & Using Models during the Summer of **2012** (as part of a two-week MSP workshop already funded by Georgia

Dept. of Education funds). So this core group will already be in a position to implement the first draft of the instructional materials in their classrooms in Fall 2012.

We plan to expand the classroom testing to additional Georgia RT3 schools by aggressively recruiting physics teachers in these schools. These new recruits will receive training, in summer 2013, during a two-week workshop. Our goal will be to recruit 10 teacher participants, primarily from the Atlanta area. This workshop will provide for a core group of teaching faculty who will apply these methods to at least one classroom at their respective schools in AY2013-2014. From this group of experienced teachers, a smaller group will be selected to run a second two-week workshop in summer 2014. Participants for the second workshop will be physics/physical science teachers recruited broadly from Georgia RT3 schools.

During this two-week workshop, faculty will work from 8-4 every weekday to explore the modeling curriculum from the vantage point of students. They will perform experiments themselves, write up their conclusions on whiteboards, solve problems in teams, and develop computational models to further enhance their learning. In addition to this work, we will regularly discuss strategies for implementing the modeling curriculum and computational thinking supplements in the diverse settings our teacher-participants represent.

Participants will leave the workshop with detailed instructional materials ready to be deployed in the classroom. In addition, they will receive additional electronic instructor resources, including videos of classroom discussions, pacing guides, solutions and detailed references for lessons and activities. Participants will also take home any lab equipment that we build as a part of the workshop.

Followup for the participants of each workshop will occur during the subsequent academic year. Once a month (4 times per semester), participants will gather for a half-day Saturday workshop hosted at Georgia Tech. This workshop will allow for more in-depth presentations and exploration of modules from the curriculum, as well as face-to-face collaboration.

Ongoing professional development will take place in two ways. Workshop participants will collaborate in a online learning network (hosted on the Google Exploring Computational Thinking website) where faculty will be asked to regularly share their experiences of using the materials in the classroom, participants will have access to discussion forums (to ask questions of other teachers and the curriculum's creators) and to a vast multitude of additional resources and videos of lessons.

Every other week, participants will also gather online for a virtual conference using the collaboration software Elluminate. This 90 minute conference will be a gathering place for faculty to listen to short special lectures or refreshers of upcoming topics in the curriculum and to discuss with one another the implementation of this curriculum in the classroom.

3.3.c Impact. In the first year of the project (Sept 2012-May 2013), the partnership will serve primarily Mays High School involving two instructors and up to a maximum of 40 students (a minimum of two physics/physical science classes with up to 20 students in each class.) In the final year of the project (June 2013-Sept 2014), Mays High School will play a leadership role in propagating methods of CT instruction in high school physics to other Georgia RT3 schools; we anticipate involving up to an additional 20 instructors (10 trained in Summer 2013 and 10 more trained in Summer 2014) with up to an additional 200 students (estimated from 10 additional classes (from teachers trained in Summer 2013) and up to 20 students per class on average.), bringing to total number of students in the final years up to a maximum of 260 (including students from the partnership schools.). Therefore, the total number of students impacted over the entire term of the proposal (ending September 2014) is expected to be up to a maximum of 300 (40 from first year + 260 from final years).

In the following table, we summarize the Scope of Work required to implement CT. More specifics of partnership responsibilities can be found in **Section 5: Quality of Project Management Plan**

RACE TO THE TOP INNOVATION FUND SCOPE OF WORK				
PARTNERSHIP: **Computational Thinking: 21st Century STEM Problem-Solving Skills for Georgia Students**				
GOAL 1: ***Classroom development, testing and implementation of Computational Thinking(CT) curricular materials for Physics in Georgia High Schools***				
ACTIVITY	IMPLEMENTATION STEPS	TIMELINE	RESPONSIBILITY	FUNDING
1st Generation Development CT Materials for Modeling Instruction Modules	Compose programming templates, instructional videos and documents for students; Compose guides, grading rubrics and notes (in Powerpoint format) for teachers; Develop CT-appropriate homework and test exercises; Develop proctored assignments for use in formative assessment.	Jan 2012-Aug 2012	Georgia Tech (Schatz; postdoc, grad students)	Atlanta Public School MSP (already funded)
Dissemination of CT Materials	Post materials to Google CT website (Forums and, upon passing internal Google review, Google CT database; Update/Curation of CT materials on Google CT website.	Sept. 2012-indefinitely	Georgia Tech (Schatz; postdoc, grad students)	Innovation Fund
Class Implementation, Testing & Evaluation of CT Materials for Modeling Instruction Modules (1st Generation)	Teach with CT materials in partnership high school (minimum 2 class, up to 40 students, in total) Incorporate Google-developed CT materials where appropriate. Classroom support by GT; Formative and summative assessment.	Sept. 2012-May 2013	Mays (Kaliasa, Caesar); GT(postdocs; grad students); FindingsGroup (McKlin)	Innovation Fund

GOAL 1 (CONTINUED): ***Classroom development, testing and implementation of Computational Thinking(CT) curricular materials for Physics in Georgia High Schools***				
ACTIVITY	**IMPLEMENTATION STEPS**	**TIMELINE**	**RESPONSIBILITY**	**FUNDING**
2st Generation Module Development	Use inputs from class testing/implementation to refine 1st Generation Development of CT Materials	Aug 2012-Aug 2013	Georgia Tech (PI; postdoc, grad students)	Innovation Fund
Class Implementation, Testing & Evaluation of CT Materials for Modeling Instruction Modules (2st Generation)	Teach with 2nd Generation CT materials (both in partnership high schools and other Georgia RT3 high schools participating in 2nd workshop). Incorporate Google-developed CT materials where appropriate. Classroom support by GT members; Formative and summative assessment.	Aug 2013-May 2014	Mays (Kaliasa, Caesar); GT (postdocs; grad students); FindingsGroup (McKlin)	Innovation Fund
Mock Interviews	Develop CT/Modeling Interview process (Devise Interview questions; develop interview rubrics); Conduct practice Interviews; Conduct/Evaluate preliminary and finalist interview candidates.	Sept 2012-Indefinite	Tapjoy (Stebar), Georgia Tech (Schatz, postdoc, grad. Students)	Tapjoy, Inc. In-kind contribution (employee time); Innovation Fund
Dissemination of CT Efforts in Peer Reviewed Journals	Preparation of manuscripts describing development, implementation, testing of CT materials; Submission of manuscripts to peer-reviewed journals; refinement of manuscripts based on referee comments.	June 2012-Sept 2014	Georgia Tech (Schatz; postdoc, grad students)	Innovation Fund

GOAL 2 : ***Foster a sustainable community of Georgia teachers with expertise in Computational Thinking***				
ACTIVITY	**IMPLEMENTATION STEPS**	**TIMELINE**	**RESPONSIBILITY**	**FUNDING**
CT/Modeling Instruction Workshop for Atlanta Area RT3 teachers	Compose workshop syllabus and materials. Teach workshop. Evaluation.	Two weeks (dates TBD) in Summer 2013	Georgia Tech (Schatz; postdoc, grad students), FindingsGroup(McKlin)	Innovation Fund
CT/Modeling Instruction Workshop Teachers at All Georgia RT3 High Schools	Incorporate refined CT materials. Teach workshop with leadership from partnership high school teachers with experience with 1st Generation CT materials. Evaluation	Two weeks (exact dates TBD) in Summer 2014	Mays (Kaliasa, Caesar); GT(postdocs; grad students); FindingsGroup(McKlin)	Innovation Fund
Half-day Workshop Followup Sessions	Face-to-Face Meetings (Peer-led) to Discuss Key Issues with CT Classroom Use.	Four Saturdays (dates TBD), Fall 2013; Spring 2014	Mays (Kaliasa, Caesar); GT(Schatz, postdocs; grad students); FindingsGroup(McKlin)	Innovation Fund
Virtual (Online) CT Community Meetings	Biweekly scheduled Elluminate meetings, hosted by GT; ad-hoc informal Google-hosted (Google+) gatherings.	Jan 2012-indefinitely	GT(Schatz, postdocs; grad students); Mays (Kaliasa, Caesar)	No cost

Section 4. Quality of Project Evaluation

4.1 Project Evaluation Description. The evaluation of this proposal will be conducted by The Findings Group, LLC, an independent evaluation organization specializing in K-16 STEM evaluation. The proposed evaluation plan is designed to provide objective measures-based feedback of both performance and results. The evaluation of the project emanates from a logic model (See Figure 1) and is designed to provide ongoing, formative feedback as well as a summative evaluation.

The evaluation draws on the long-term goals of the Innovation Fund. The first goal, "Adopting standards and assessments that prepare students to succeed in college and the workplace and to compete in the global economy," is addressed through the program's introduction of a viable curriculum and professional learning opportunities to support students in complex problem-solving. Student success is measured formatively through modeled think-aloud protocols and the Force Concepts Inventory (FCI) and summatively through end-of-course tests. The second goal, "Building data systems that measure student growth and success, and informing teachers and principals about how they can improve instruction," is addressed through the creation of a logic model which traces the program's best thinking from curriculum and professional development to instructional activity to student achievement. The logic model identifies how the program's activities affect critical predictors of teacher success (teachers' ability to provide increased academic rigor and more opportunities for real-world practice) and student success (increased self-management through improved problem-solving skills, communication skills, and student engagement). By changing these critical faculty and student predictors, two outcome variables should be affected (students' intentions to persist in STEM and their actual achievement). This program enables line-of-sight measurement starting from curriculum development and teacher participation in professional learning, on through classroom changes toward changes in student success predictors, and finally to student outcomes.

Third, the partnership between program participants, program staff, and The Findings Group, LLC, addresses the third long-term goal of the Innovation Fund, "Recruiting, preparing, rewarding, and retaining effective teachers and principals, especially where they are needed most." The partnership addresses this goal by engaging teachers in the evaluation process. The evaluation plan specifically includes teachers as stakeholders, data collectors, and critical informants. Participating teachers are stakeholders who provide guidance to the program in response to formative and summative evaluation reports. The evaluation plan asks them to collect rubric-based data on student communication skills, incorporate think-aloud protocol techniques as formative indicators of student learning, and to administer

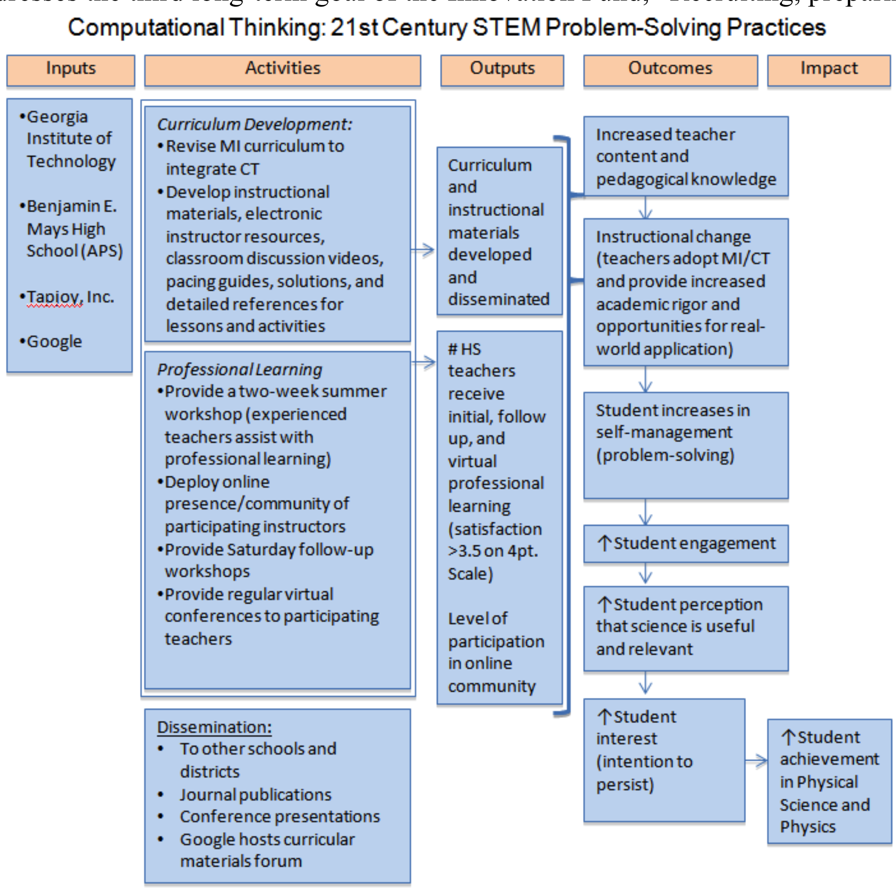


Figure 1: Logic Model for Project Evaluation.

student surveys. Finally, participating teachers are critical informants asked to report on the connections between teacher professional development, classroom changes, and anticipated student outcomes. Fourth, the partnership addresses the fourth long-term goal, “Turning around our lowest-achieving schools.” National data indicate that the impacted schools are in the bottom third in the country. This partnership focuses not only on measuring student achievement but also on measuring the achievement of populations of students in comparison with one another.

Overall, the evaluation plan is designed to measure critical points between teacher professional development and student achievement. It enumerates the number of teachers served, their use of scientifically-proven techniques, changes in instruction, the impact of those changes on student characteristics (e.g. problem-solving skills, engagement), and students’ intentions to persist in STEM.

4.2 Project Evaluation Table. The Project Evaluation Table indicates the methods to be used that emanate from both the Georgia Race to the Top Innovation Fund Request for Proposals Announcement and Application Instructions and the program’s logic model.

1. Georgia benefits from a stronger understanding of the types of innovative programs, strategies, and practices that will lead to positive improvements in applied learning, teacher induction, and homegrown teacher pipeline efforts*		
Indicator(s)	Data Collection Methods(s)	Frequency of Data Collection/Review
Participating students demonstrate improvements in self-management skills (**problem solving**) from beginning of the academic year to the end.	Student problem-solving abilities often lie in their perceptions about their own problem-solving abilities such as their goal orientation, interest, critical thinking, metacognitive self regulation, effort regulation, and help seeking. We propose to measure problem-solving, engagement, self-management skills, and student perceptions that science is useful and relevant using the Motivated Strategies for Learning Questionnaire (MLSQ). Intentions around continuing STEM education and career is gauged using the Intention to Persist scale (Cronbach’s alphas range from 0.81 to 0.93) Teacher rubric to assess student problem solving skills. Evaluators collect scores and compare scores of students at beginning of year to those at the end of course.	Annually with a pre-administration in September and post-administration in late March or early April.

*This proposal specifically addresses improvement in applied learning

2. **Georgia benefits from a measurably stronger commitment from public and private sectors to support and advance positive academic outcomes for students**		
Indicator(s)	Data Collection Methods(s)	Frequency of Data Collection/Review
Dollar amount raised or leveraged to support ongoing implementation of proposed initiative	Collection and tally of project donations and funding sources	Annually, reflectively in June.

3. Georgia benefits from improved student outcomes		
Indicator(s)	Data Collection Methods(s)	Frequency of Data Collection/Review
Summative Indicators Increased student achievement among high school students as measured by improvements on the Physical Science EOCT and the Advanced Placement Physics Exam Increased student achievement among high school students as measured by improvements in problem solving capabilities Track participating student performance during problem-solving scenarios using teacher-created rubrics	1. Participating schools report Physical Science EOCT scores (compare year-to-year change between participating schools and non-participating APS schools) 2. Track participating student performance on the Advanced Placement Physics B and Physics C exams 3. Track participating student performance during problem-solving scenarios using teacher-created rubrics	1. EOCT data are reported annually by participating schools 2. AP Physics B and C data are reported annually 3. Students are assessed regularly (at least 4 times) during the course of the academic year.
Formative Indicators Near-term measures of student and teacher content knowledge include think-aloud protocols and the Force Concepts Inventory (FCI)	Think aloud protocols administered to both teacher and student participants. For teachers, this is used to measure changes in teacher content knowledge. For students, this may be modeled as a technique for teachers to gauge near-term student learning. Pre/Post measures of student content knowledge using Force Concepts Inventory (compare year-to-year change between participating students to a comparison group of over 20,000 students participating in ASU's Modeling Instruction in High School Physics Project)	3. Think-aloud protocols modeled near the end of the summer workshop for teachers 4. Force Concepts Inventory offered as a pre/post measure to participating students at the beginning and end of each semester.

4. Georgia benefits from an increased number and percentage of students and teachers who will have access to innovative programs, strategies, and practices related to applied learning and teacher/leader recruitment and development		
Indicator(s)	Data Collection Methods(s)	Frequency of Data Collection/Review
Number of high school teachers using novel strategies; Number of high school students served; Number of teachers participating in professional development opportunities	Participant database	Updated quarterly

5. Additional measures: Outputs and instructional change		
Indicator(s)	Data Collection Methods(s)	Frequency of Data Collection/Review
Teacher professional development outputs	Tracking tools (sign-in sheets and activity logs) to measure the number of teachers receiving initial, follow up, and virtual professional learning.	Monthly updates to tracking tools. Data will be analyzed using descriptive statistics.
	Online community log data to track teacher participation	Monthly
Instructional change	Interviews or group interviews with participating teachers.	Annual interviews using an interview protocol following Guskey's model for professional development

Section 5. Quality of Project Management Plan

The members of the partnership are tasked with the following responsibilities (referring to the Activities and Timelines listed in the Scope of Work Table in **Section 3)**:

Georgia Tech School of Physics (Lead Partner): As detailed in **Section 1**, the PI at the Lead Partner has extensive background experience and training in managing large, complex, and rapidly-growing projects in education that achieved positive outcomes on time and within budget. The PI is responsible for the overall supervision of all aspects of the project; moreover, the PI bears responsibility for supervising both a postdoctoral researcher and two graduate students, who, together with the PI, assume the leadership role in a number of aspects of both Goals. In Goal 1, the PI, postdoc, and graduate students will take the lead in developing CT materials for Modeling Instruction modules, dissemination of CT materials, formative assessment of CT materials in the classroom, and dissemination of CT Efforts in peer reviewed journals. The PI, postdoc, and graduate students will be involved with the development of the Mock Interviews (under the guidance and supervision of Tapjoy, Inc), including the design of interview questions, the structuring of interview judging rubrics, and the operation of the practice and first-round interviews (to be conducted by Georgia Tech personnel). In Goal 2, the PI, postdoc and graduate students will take the lead in organizing and conducting the CT/Modeling Instruction Workshop for Teachers in Partnership Schools and the Half-day Workshop Followup Sessions. Moreover, the PI, postdoc and graduate students will co-organize and co-lead conducting CT/Modeling Instruction Workshop for Teachers in Other Georgia RT3 schools as well as the Virtual Online Community Meetings. Finally, the PI, postdoc, and graduate students will support the Classroom Implementation and Testing of CT materials for Modeling Instruction Modules.

Mays High School: The primary responsibility for Classroom Implementation and Testing of CT materials for Modeling Instruction Modules will rest with Mays (Kaliasa and Caesar). Additionally, Kaliasa and Caesar will co-organize and co-lead conducting CT/Modeling Instruction Workshop for Teachers in Other Georgia RT3 schools as well as the Virtual Online Community Meetings.

Tapjoy, Inc: Brian Stebar and co-workers at Tapjoy, Inc. will have the primary responsibility of providing the expertise and guidance to ensure that the planned Mock Interviews will give students a real-world experience of Computational Thinking. Specifically, Tapjoy (Stebar) will review the materials developed at Georgia Tech, including the design of interview questions and the structure of interview judging rubrics. Tapjoy will also interact with Georgia Tech personnel to insure the practice and first-round interviews (to be conducted by Georgia Tech personnel) are realistic. Additionally, Tapjoy personnel (Stebar and coworkers) will conduct interviews and supervise the judging for the finalists in the Mock Interview process.

Section 6. Quality of Sustainability/Scalability Plan

Any STEM reform, however valuable, is worthless unless the reform is sustained. The sustainability of the work in Computational Thinking proposed here rests on a **solid foundation** based on: (1) The long-term commitment (beyond the expiration date of the proposed grant) of each collaborator and partnership member to serve as a Core Group to sustain CT reforms (**See Letters of Support in the Appendix explicitly indicating Long-Term Commitments from EVERY Partnership Member and Collaborator (Google)**), (2) The effort, in this proposal, to recruit instructors in other Georgia RT3 schools to use CT in their STEM instruction, and (3) The online virtual community activities on CT in K-12 education that will be fostered during the proposed grant period and that, we anticipate, will go “viral” and, thereby, be sustained well-beyond the expiration of the proposed grant.

Every member and collaborator in this partnership forms a Core Group dedicated to nurturing and to sustaining CT in STEM. The past track record of each partner member's commitment to developing STEM expertise (e.g., the Modeling Instruction experience of Mays (Kailasa and Caesar) and the Computational Thinking reforms at Georgia Tech (Schatz)) shows that each partner member is in this effort for the long haul. Moreover, as previously mentioned (**Section 1**), Google is fully committed to CT in K-12 for the long term (see Google Letter of Support in the Appendix); **each partner member recognizes that to take advantage of the golden opportunity to foster and to grow a close working relationship on Computational Thinking in K-12 STEM education with one of the world's premier technology companies requires a commitment to a long-term effort well beyond the duration of this proposal.**

While the members of the partnership are the Core Group, the members recognize that they can't sustain such reforms alone. Thus, the efforts to involve other Georgia RT3 high schools beyond the partner schools (by means of the proposed CT/Modeling Instruction Workshops in Summers 2013 & 2014 and by supporting the classroom testing of 2nd Generation CT materials in other Georgia RT3 schools in AY2013-2014) serve equally important roles both to spread CT reforms across Georgia and to nurture a community of committed CT instructors that are vital to sustaining these reforms.

Well after the end of the proposed grant, online venues (the learning network hosted on the Google Exploring Computational Thinking website and the Elluminate virtual conferences) will provide the crucially important communication channels needed to sustain the CT teaching community. The PI commits to continue hosting the Elluminate virtual conferences from Georgia Tech on a regular basis; moreover, after the end of the proposed grant period, open access will be provided to any educator (in Georgia or outside Georgia) who wants to participate. Similarly, open access on Google forums will be provided to any educator (regardless of geographic location) with an interest in CT. This open access approach is key to long-term sustainability; continually growing the size of the CT teaching community (including instructors in disciplines outside of physics) provides a way for CT to spread into other STEM disciplines. Having CT "go viral" in this manner is in the best interests of Georgia; in this way, Georgia, having established a leadership position in K-12 Computational Thinking by means of the work proposed here, is then well-positioned to take advantage of future CT developments (regardless of their origin) that arise from a vibrant, growing CT teaching community.

REFERENCES:

[Reference 1]: http://www.nextgenscience.org/three-dimensions

[Reference 2]: "A Framework for K-12 Science Education", National Research Council of the National Academies of Science and Engineering (2012). All citations to this reference listed in this proposal are drawn from the document in pdf format; this document is freely available for download from: http://www.nap.edu/catalog.php?record_id=13165

[Reference 3]: Chapter 9, Pages 217-218 (using pagination embedded within document) of Reference 2.

[Reference 4]: Chapter 3, Page 42 (using pagination embedded within document) of Reference 2.

[Reference 5]: http://modeling.asu.edu/modeling-HS.html

[Reference 6]: http://www.nsf.gov/awardsearch/piSearch.do;jsessionid=25CAE21A58DCBD11E17F62D2613DC3D2?SearchType=piSearch&page=1&QueryText=&PIFirstName=michael&PILastName=schatz&PIInstitution=&PIState=&PIZip=&PICountry=&Restriction=0&Search=Search#results

[Reference 7]: M. Kohlmyer et al, *Phys. Rev. Special Topics: Physics Ed. Research* **5**, 020105 (2009). See also: http://prst-per.aps.org/abstract/PRSTPER/v5/i2/e020105

[Reference 8]: M D. Caballero et al, *American Journal of Physics* **80**, 638 (2012). See also:

http://ajp.aapt.org/resource/1/ajpias/v80/i7/p638_s1?isAuthorized=no&Type=ALERT

[Reference 9]: http://www.commonwealthfoundation.org/policyblog/detail/sat-scores-by-state-2011

[Reference 10]: Chapter 5, Page 105 (using pagination embedded within document) of Reference 2.

[Reference 11]: http://www.astro.ucla.edu/~ghezgroup/gc/

[Reference 12]: http://services.google.com/edu/computational-thinking/forum.html?place=topic/science-ect-forum/dzYg6Gq4VQs

GOVERNOR'S OFFICE OF STUDENT ACHIEVEMENT
RACE TO THE TOP INNOVATION FUND BUDGET FORM

Project Name: Computational Thinking: 21st Century STEM Problem-Solving Practices for Georgia Students	Applicants requesting Venture grants should complete the column under "Project Year 1." Applicants requesting funding for Enterprise grants should complete all applicable columns. Please read all instructions before completing form.

SECTION A - BUDGET SUMMARY
INNOVATION FUND COSTS

Budget Categories	Project Year 1 (a)	Project Year 2 (b)	Total (d)
1. Personnel	$95,367	$98,228	$193,595
2. Fringe Benefits	$14,048	$14,469	$28,517
3. Travel			
4. Equipment			
5. Supplies	$29,630	$5,630	$35,260
6. Contractual	$20,055	$17,838	$37,893
7. Construction			
8. Other	$28,080	$30,326	$58,406
9. Total Direct Costs (lines 1-8)	$187,180	$166,491	$353,671
10. Indirect Costs*	$15,910	$13,617	$29,527
11. Training Stipends	$24,000	$24,000	$48,000
12. Total Costs (lines 9-11)	$227,090	$204,108	$431,198

SECTION B - BUDGET SUMMARY
NON-INNOVATION FUND COSTS

Budget Categories	Project Year 1 (a)	Project Year 2 (b)	Total (d)
1. Personnel			
2. Fringe Benefits			
3. Travel			
4. Equipment			
5. Supplies			
6. Contractual			
7. Construction			
8. Other			
9. Total Direct Costs (lines 1-8)			
10. Indirect Costs*			
11. Training Stipends			
12. Total Costs (lines 9-11)			

SECTION C – BUDGET NARRATIVE (see instructions)

GEORGIA RACE TO THE TOP
INNOVATION FUND
BUDGET NARRATIVE

Personnel: Two weeks of summer support is requested for 2013 and 2014 for the PI (Schatz), who will be responsible for the overall project administration (e.g., workshop organization, supervision of postdoctoral and graduate students, etc.). The full time support (12 months) of two physics education graduate students and one physics education postdoctoral fellow is crucial for the success of the proposed research program in terms of supporting development of curricular materials, assisting in classroom testing, conducting formative and summative assessments, collecting, coding, and analyzing data, supporting the organization and operation of teacher training workshops. Salaries/wages are based upon University established rates/salaries which are comparable to other research effort both within and outside the University.

Fringe Benefits: Fringe benefits (27.9%) are charged on the salary support for the PI and postdoc. Fringe benefits (1.8%) are charged on the salary for graduate students. These are provisional rates for FY13.

Supplies: For Year 1, $24000 is requested for 30 laptops for students to be used in classroom testing at Mays (30 laptops). For Years 1 and 2, $315 per year ($630 total) is requested for 30 software licenses ($10.50/per year/per license) for students to be used in classroom testing at Mays (30 licenses). Funds are also requested for the workshops in Year 1 ($5000) and Year 2 ($5000) for the construction of materials necessary for teacher training in Modeling Instruction with Computational Thinking.

Contractual: Funds are requested to support external evaluation of the proposed work by the Findings Group, as detailed in Section 4 of the Project Narrative.

Other: Graduate Student Tuition Remission–The provisional FY13 rate is $1,170 per student per month. Tuition fees are increased incrementally at a rate of 8% each year.

Indirect Costs: Indirect Costs are 10% of the Modified Total Direct Costs which are the Total Direct Costs excluding Tuition Remission

Training Stipends: Stipends are requested for teachers (at $2000/ per teacher/ per workshop) participating in the workshops. For the workshop in year 1, $24000 is requested for 12 teacher participants from the partner schools (2 from Mays, 10 recruited from Atlanta-area RT3 schools). For the workshop in year 2, $24000 is requested for 12 new teacher participants recruited from RT3 schools both in the Atlanta-area and across Georgia.

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU) is entered into by and between the Governor's Office of Student Achievement (GOSA) and Georgia Tech, Mays H.S. + Tapjoy, Inc. (Partners). The purpose of this agreement is to establish a framework of collaboration, as well as articulate specific roles and responsibilities in support of the State in its implementation of approved Innovation Fund projects. **Any partner named in the aforementioned project will only be considered a member of the partnership if they appear on this Memorandum of Understanding with the State**

I. SCOPE OF WORK

Exhibit 1, the Preliminary Scope of Work, indicates the work that the Partnership is agreeing to implement.

II. PROJECT ADMINISTRATION

A. PARTNERSHIP RESPONSIBILITIES

The Partnership agrees to:

1) Implement the plan as identified in Exhibit I of this agreement;
2) Actively participate in all relevant convenings, communities of practice, or other practice-sharing events that are organized or sponsored by GOSA, the Georgia Department of Education, the Governor's Office of Student Achievement and the US Department of Education;
3) Post to any website specified by the State in a timely manner, all non-proprietary products and lessons learned using funds associated with the Innovation Fund;
4) Participate, as requested, in any evaluations of this grant conducted by the State or agency conducting business on behalf of the State;
5) Be responsive to State requests for information including the status of the project, project implementation, outcomes, and any problems anticipated or encountered; and
6) Participate in meetings and telephone conferences with the State to discuss (a) progress of the project, (b) potential dissemination of resulting non-proprietary products and lessons learned, (c) plans for subsequent years of the Innovation Fund grant period, and (d) other matters related to the Innovation Fund grant and associated plans.

B. STATE RESPONSIBILITIES

The State agrees to:

1) Timely distribute the Partnership's grant during the course of the project period;
2) Provide feedback on the Partnership's status updates, annual reports, any interim reports, and projects plans and products; and
3) Identify sources of technical assistance for the project.

C. JOINT RESPONSIBILITIES

1) GOSA and the Partnership will each appoint a key contact person for the Innovation Fund grant.
2) These key contacts from GOSA and the Partnership will maintain frequent communication to facilitate cooperation under this MOU.
3) State and Partnership grant personnel will work together to determine appropriate timelines for project updates and status reports throughout the grant period.
4) State and Partnership grant personnel will negotiate in good faith to continue to achieve the overall goals of the Innovation Fund.

D. STATE RECOURSE FOR PARTNERSHIP NON-PERFORMANCE

If GOSA determines that the Partnership is not meeting its goals, timelines, budget, or annual targets or is not fulfilling other applicable requirements, GOSA will take appropriate enforcement action, which could include a collaborative process between GOSA and the Partnership, or any of the enforcement measures that are detailed in 34 CFR section 80.43 including putting the Partnership on reimbursement payment status, temporarily withholding funds, or disallowing costs.

III. ASSURANCES

The Partnership hereby certifies and represents that it:

1) Has all requisite power and authority to execute this MOU;
2) Agrees to implement the work indicated in Exhibit I, if funded;
3) Will comply with all terms of the grant and all applicable Federal and State laws and regulations, including laws and regulations applicable to the Race to the Top program and the applicable provisions of EDGAR (34 CFR Parts 74,75, 77, 79, 80, 81, 82, 84, 85, 86, 97, 98 and 99).

IV. MODIFICATIONS

This Memorandum of Understanding may be amended only by written agreement signed by each of the parties involved.

V. DURATION/TERMINATION

This Memorandum of Understanding shall be effective, beginning with the date of the last signature hereon and, if a grant is received, ending upon the expiration of the grant project period, or upon mutual agreement of the parties, whichever occurs first.

VI. SIGNATURES

Partnership Executive Official – required:

[signature] 7/10/12

Signature/Date

Christopher E. DiUrbano, Division Manager

Print Name/Title

Partnership Member

Partnership Member – required:

Dante Edwards 7/9/12

Signature/Date

Dante Edwards / Academy Leader

Print Name/Title

Partnership Member – required:

[signature] July 9, 2012

Signature/Date

Brian J. Stebar, II / Senior Software Engineer

Print Name/Title

Governor's Office of Student Achievement – required:

____

Signature/Date

____

Print Name/Title

ADDENDUM TO MOU

- It is understood and agreed that the term "partnership" as used in this RFP is considered to mean a collaborative relationship amongst the parties as opposed to a "legal partnership" as defined by law. All parties are and shall remain separate entities and nothing in the Memorandum of Understanding or Exhibit 1 shall be construed to create a joint venture or partnership. No party shall act as the agent for another except for the purpose of submitting the proposal. If an award is made, written definitive agreements among the parties shall govern their future relationship.

- Each party will bear all costs of preparation and publication of the final proposal to be submitted.

- Each party agrees that it will be responsible for its own acts and the results thereof and shall not be responsible for the acts of the other party and the results thereof. Each party will assume all risks and liability to itself, its agents, or employees for any injury to persons or property resulting solely from the conduct of its own operations or the operations of its agents or employees under this agreement and for any loss, costs, damages or expenses due to any acts, negligence or the failure to exercise proper precautions, solely by itself or its agents or employees.

ASSURANCES

The Applicant hereby assures and certifies compliance with all federal statutes, regulations, policies, guidelines and requirements, including OMB Circulars No. A-21, A-87, A-110, A-122, A-133; E.O. 12372 and Uniform Administrative Requirements for Grants and Cooperative Agreements 28 CFR, Part 66, Common rule, that govern the application, acceptance and use of federal funds for this federally-assisted project.
Also the Applicant assures and certifies that:

1. It possesses legal authority to apply for the grant; that a resolution, motion or similar action has been duly adopted or passed as an official act of the applicant's governing body, authorizing the filing of the application, including all understandings and assurances contained therein, and directing and authorizing the person identified as the official representative of the applicant to act in connection with the application and to provide such additional information
2. It will comply with requirements of the provisions of the Uniform Relocation Assistance and Real Property Acquisitions Act of 1970 (P.L. 91-646) which provides for fair and equitable treatment of persons displaced as a result of federal and federally - assisted programs.
3. It will comply with provisions of federal law which limit certain political activities of employees of a State or local unit of government whose principal employment is in connection with an activity financed in whole or in part by federal grants. (5 USC 1501, et seq.)
4. It will comply with the minimum wage and maximum hours provisions of the Federal Fair Labor Standards Act if applicable.
5. It will establish safeguards to prohibit employees from using their positions for a purpose that is or gives the appearance of being motivated by a desire for private gain for themselves or others, particularly those with whom they have family, business, or other ties.
6. It will give the sponsoring agency or the Comptroller General, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the grant.
7. It will comply with all requirements imposed by the federal sponsoring agency concerning special requirements of law, program requirements, and other administrative requirements.
8. It will insure that the facilities under its ownership, lease or supervision which shall be utilized in the accomplishment of the project are not listed on the Environmental Protection Agency's (EPA) list of Violating Facilities and that it will notify the federal grantor agency of the receipt of any communication from the Director of the EPA Office of Federal Activities indicating that a facility to be used in the project is under consideration for listing by the EPA.
9. It will comply with the flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973, Public Law 93-234, 87 Stat. 975, approved December 31, 1976, Section 102(a) requires, on and after March 2, 1975, the purchase of flood insurance in communities where such insurance is available as a condition for the receipt of any federal financial assistance for construction or acquisition purposes for use in any area that has been identified by the Secretary of the Department of Housing and Urban Development as an area having special flood hazards. The phrase "federal financial assistance" includes any form of loan, grant, guaranty, insurance payment, rebate, subsidy, disaster assistance loan or grant, or any other form of direct or indirect federal assistance.
10. It will assist the federal grantor agency in its compliance with Section 106 of the National Historic Preservation Act of 1966 as amended (16 USC 470), Executive Order 11593, and the Archeological and Historical Preservation Act of 1966 (16 USC 569 a-1 et seq.) by (a) consulting with the State Historic Preservation Officer on the conduct of investigations, as necessary, to identify properties

listed in or eligible for inclusion in the National Register of Historic Places that are subject to adverse effects (see 36 CFR Part 800.8) by the activity, and notifying the federal grantor agency of the existence of any such properties, and by (b) complying with all requirements established by the federal grantor agency to avoid or mitigate adverse effects upon such properties.

11. It will comply, and assure the compliance of all its sub-grantees and contractors, with the applicable provisions of Title I of the Omnibus Crime Control and Safe Streets Act of 1968, as amended, the Juvenile Justice and Delinquency Prevention Act, or the Victims of Crime Act, as appropriate; the provisions of the current edition of the Office of Justice Programs Financial and Administrative Guide for Grants, M7100.1; and all other applicable federal laws, orders, circulars, or regulations.

12. It will comply with the provisions of 28 CFR applicable to grants and cooperative agreements including Part 18, Administrative Review Procedure; Part 20, Criminal Justice Information Systems; Part 22, Confidentiality of Identifiable Research and Statistical Information; Part 23, Criminal Intelligence Systems Operating Policies; Part 30, Intergovernmental Review of Department of Justice Programs and Activities; Part 42, Nondiscrimination/Equal Employment Opportunity Policies and Procedures; Part 61, Procedures for Implementing the National Environmental Policy Act; Part 63, Floodplain Management and Wetland Protection Procedures; and federal laws or regulations applicable to Federal Assistance Programs.

13. It will comply, and all its contractors will comply, with the nondiscrimination requirements of the Omnibus Crime Control and Safe Streets Act of 1968, as amended, 42 USC 3789(d), or Victims of Crime Act (as appropriate); Title VI of the Civil Rights Act of 1964, as amended; Section 504 of the Rehabilitation Act of 1973, as amended; Subtitle A, Title II of the Americans with Disabilities Act (ADA) (1990); Title IX of the Education Amendments of 1972; the Age Discrimination Act of 1975; Department of Justice Non-Discrimination Regulations, 28 CFR Part 42, Subparts C, D, E, and G; and Department of Justice regulations on disability discrimination, 28 CFR Part 35 and Part 39.

14. In the event a federal or state court or federal or state administrative agency makes a finding of discrimination after a due process hearing on the grounds of race, color, religion, national origin, sex, or disability against a recipient of funds, the recipient will forward a copy of the finding to the Office for Civil Rights, Office of Justice Programs.

15. It will provide an Equal Employment Opportunity Program if required to maintain one, where the application is for $500,000 or more.

16. It will comply with the provisions of the Coastal Barrier Resources Act (P.L. 97-348) dated October 19, 1982 (16 USC 3501 et seq.) which prohibits the expenditure of most new federal funds within the units of the Coastal Barrier Resources System.

17. It will comply will all ARRA requirements. All funds must be spent with an unprecedented level of transparency and accountability. Accordingly, recipients of ARRA funds must maintain accurate, complete, and reliable documentation of all ARRA expenditures.

Authorizing Official:

Division Manager 7/10/12

Signature and Title Date

NON-SUPPLANTING CERTIFICATION

Regulations require certification to the effect that grant funds will not be used to increase state or local funds that would, in the absence of such grant aid, be made available for the purpose of this grant program.

CERTIFICATION:

I certify that grant funds will not be used to supplant state or local funds that would otherwise be available for implementation of this grant program.

I further certify that the program proposed in the grant application meets all the requirements of the applicable Race to the Top Innovation Fund Request for Proposal; that all the information presented is correct and that the applicant will comply with the provisions of the Governor's Office of Student Achievement, all applicable federal and state laws, and the above mentioned certification should a grant be awarded.

Authorizing Official:

____
Signature

Division Mgr 7/10/12
Title Date

IMMIGRATION AND SECURITY FORM

A. In order to insure compliance with the Immigration Reform and Control Act of 1986 (IRCA), D.L. 99-603 and the Georgia Security and Immigration Compliance Act OCGA 13-10-90 et.seq., Contractor must initial one of the sections below:

Contractor has 500 or more employees and Contractor ~~warrants~~ certifies that Contractor has complied with the Immigration Reform and Control Act of 1986 (IRCA), D.L. 99-603 and the Georgia Security and Immigration Compliance Act by registering at https://www.vis-dhs.com/EmployerRegistration and verifying information of all new employees; and by executing any affidavits required by the rules and regulations issued by the Georgia Department of Labor set forth at Rule 300-10-1-.01 et.seq. Contractor has 100-499 employees and Contractor ~~warrants~~ certifies that no later than July 1, 2008, Contractor will register at https://www.visdhs.com/EmployerRegistration to verify information of all new employees in order to comply with the Immigration Reform and Control Act of 1986 (IRCA), D.L. 99-603 and the Georgia Security and Immigration Compliance Act; and by executing any affidavits required by the rules and regulations issued by the Georgia Department of Labor set forth at Rule 300-10-1-.01 et.seq. Contractor has 99 or fewer employees and Contractor ~~warrants~~ certifies that no later than July 1, 2009, Contractor will register at https://www.visdhs.com/EmployerRegistration to verify information of all new employees in order to comply with the Immigration Reform and Control Act of 1986 (IRCA), D.L. 99-603 and the Georgia Security and Immigration Compliance Act; and by executing any affidavits required by the rules and regulations issued by the Georgia Department of Labor set forth at Rule 300-10-1-.01 et.seq.

B. Contractor ~~warrants~~ certifies that Contractor has included a similar provision in all written agreements with any subcontractors engaged to perform site under this Contract.

Authorizing Official:

Division Mgr 7/10/12

Signature and Title Date

CERTIFICATION REGARDING LOBBYING (ED 80-0013)

Certification for Contracts, Grants, Loans and Cooperative Agreements.

The undersigned certifies, to the best of his or her knowledge and belief, that:

1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal Loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan or cooperative agreement.

2) If any funds other Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loam or cooperative agreement, the undersigned shall complete and submit Standard Form – LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Statement for Loan Guarantees and Loan Insurance.

The undersigned states, to the best of his or her knowledge and belief, that:

If any funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee or any agency, a member of Congress, an officer or employee of Congress or an employee of a Member of Congress in connection with this commitment providing for the United States to insure or guarantee a loan, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions. Submission of this statement is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required statement shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Authorizing Official:

Division Manager 7/10/12

Signature and Title Date

OTHER CERTIFICATIONS

Regulations require certification to the effect that grant funds will not be used to increase state or local funds that would, in the absence of such grant aid, be made available for the purpose of this grant program.

1. Any person associated with the program that has reasonable cause to believe that a child has been or is being abused, shall be required to report or cause report to be made with regard to the abuse as provided in O.C.G.A. 19-7-5.

2. Background investigations (Georgia Crime Information Center) are required on all persons with direct contact with children and youth. It is left to the discretion of the Partnership to determine the methodology for completing these investigations.

3. Establish/enforce an Internet Security Policy when minor participants and/or staff have online access (supervised or unsupervised). This includes any technology provided by PLC funding and technology used by participants.

4. The grantee agrees to comply with Public Law 103-227, also known as the Pro-Children Act of 1994, which requires that smoking not be permitted in any portion of any indoor facility owed or leased or contracted for by the grantee and used routinely or regularly for the provision of healthy care, day care, early childhood development site, education or library site to children under the age of 18. Failure to comply with the provisions of the law may result in the imposition of a civil monetary penalty up to $1,000 for each violation and/or the imposition of an administrative compliance order on the grantee.

Authorizing Official:

[signature]
Signature

Division Manager — 7/10/12
Title — Date

Google Inc.
1600 Amphitheatre Parkway
Mountain View, CA 94043

Google

Main 650 253.0000
Fax 650 253.0001
www.google.com

Program Managers
Georgia Race to the Top Innovation Fund

Dear Sir or Madam:

I am writing to express our support for the proposal entitled, "Computational Thinking: 21st Century STEM Problem-Solving Skills for Georgia Students", submitted to the Georgia Race to the Top Innovation Fund. Computational thinking centers on a set of problem-solving ideas and techniques, which typically require the creation of computer programs. In the software world, computational thinking comes into play when engineers write programs that underlie widely-used computer applications such as search, email, and maps; however, computational thinking is also central to the way modern scientists, engineers and mathematicians do problem solving. Google is strongly committed to efforts that promote, explore and develop K-12 student learning of this vital skill. We believe widespread learning of computational thinking could help raise significantly the scientific and technical literacy of K-12 students, thereby radically improving the ability of these students to grapple with current and future societal challenges, which typically involve substantial scientific and technical content. Google has committed resources to fostering computational thinking in K-12 students and stands ready to partner with collaborators in this endeavor.

Toward that end, Google is willing to support this proposal by:

(1) Providing a forum for widespread dissemination of any materials developed under this proposal. This dissemination will be done primarily through our website (http://www.google.com/edu/ect/). Materials can be posted anywhere on the web and disseminated using links provided in our computational thinking discussion boards (http://services.google.com/edu/computational-thinking/forum-toc.html). Moreover, materials that pass our internal review process may be added to our Exploring Computational Thinking (ECT) lessons alongside materials that are developed in-house at Google (http://www.google.com/edu/computational-thinking/lessons.html).

(2) Providing, as they become publicly available, appropriate computational thinking curricular materials, developed in-house at Google, for evaluation and use in this proposal.

We emphasize that this expression of support should not be considered exclusive; Google stands ready to partner, with equal vigor, with any persons or organizations committed to advancing computational thinking in K-12 education.

Efforts to develop computational thinking in K-12 are still in their infancy. This Georgia Tech-led effort would be a welcome thought partner in this space.

Sincerely,

Nina Kim Schultz
Engineering Manager, Google Education Research
Google Inc.
1600 Amphitheatre, Building 46
Mountain View, CA 94043

Program Managers
Georgia Race to the Top Innovation Fund

Dear Sir or Madam:

I am writing to express our enthusiasm for the proposal: "Computational Thinking: 21st Century Problem Solving Practices for Georgia Students." At Tapjoy, the lifeblood of our company is a cadre of dedicated professionals who work tirelessly to apply creatively Computational Thinking in the development of the cutting-edge software services that we offer in the mobile device space. It is in our best interest to do what we can to help foster Computational Thinking practices in students, who may, in the future, become employees in high technology companies like ours. Toward that end, we are pleased to join in partnership with Georgia Tech and Mays High School and are willing to help support the Mock Interview component described in the proposal, thereby providing Georgia high school students an opportunity to see and to experience how Computational Thinking comes into play in business out in the "real world".

Sincerely,

Brian Stebar II
Software Engineer, Atlanta office

Tapjoy, Inc. 111 Sutter Street, 13th Floor, San Francisco, CA 94104 p. 415.766.6900

ATLANTA PUBLIC SCHOOLS
Making A Difference

Benjamin E. Mays High School
DR. ARUNA KAILASA
CHEMISTRY TEACHER
3450 B. E. MAYS DRIVE SW
Atlanta, Georgia 30331
(404) 802-5100 (PHONE)
(404) 505-5104 (FAX)
AKAILASA@ATLANTA.K12.GA.US

July 10, 2012

To whom it may concern:

I am writing to confirm my enthusiastic participation in the project entitled, Computational Thinking: 21st Century STEM Problem-Solving Skills for Georgia Students. I am looking forward to participate in developing and testing novel Computational Thinking curricular materials for my students to motivate these i-generation students in my classes. I intend to continue to use these materials well past the 3 year timetable of the Race to the Top Grant.

Sincerely,

Aruna Kailasa

ATLANTA PUBLIC SCHOOLS
Making A Difference

Benjamin E. Mays High School
SHEELA ABRAHAM CAESAR
Physics Teacher
3450 Benjamin E. Mays Drive
Atlanta, GA 30331
(404) 802-5110 (PHONE)
(404) 802-5195 (FAX)
SCAESAR@ATLANTA.K12.GA.US

June 15, 2012

To Whom It May Concern:

I am writing to confirm my enthusiastic participation in the project entitled, **Computational Thinking: 21st Century STEM Problem - Solving Skills for Georgia Students.** I am looking forward to participate in developing and testing novel Computational Thinking curricular materials for my students to motivate these i-generation students in my classes. I intend to continue to use these materials well past the three year timetable of the Race to the Top Grant.

Sincerely,

Sheela Caesar

Sheela Caesar
Science Educator, BE Mays HS