Coding in K-8 Classrooms: Empowering A New Generation of Creators

“Coding is today’s language of creativity. All our children deserve a chance to become creators instead of consumers of computer science.”

- Maria Klawe
Computer Scientist, Scholar, and First Woman President of Harvey Mudd College

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Our nation's schools are more focused today than ever before on ensuring that today's students have the college, career, and citizenry skills they need to be successful in the future. Guided by high-profile national organizations and advocacy from the corporate community, K-12 schools are now in the business of connecting students' classroom learning experiences to their development of key workplace skills such as critical thinking, collaboration, communications, and creativity. As a commitment to equity of opportunity, school leaders have adopted what would be a radical position in a previous time–that all students, regardless of zip code, family demographics, or post-graduation aspirations—must be provided with learning experiences that support workplace skill development. This commitment is actualized in new learning standards and as such, classroom initiatives are increasingly evaluated by their propensity to enable skill development by all students. A key finding from the Speak Up Research Project findings is the increasing use of digital content, tools, and resources in the classroom to level the in-school playing field and empower the acquisition of those new skills by all students. Significant within this environment today is a seemingly universal agreement about the value of students acquiring fluency in coding, computer programming, or computational thinking as part of that preparation for a successful future.

This position, shared by parents and principals, college professors, and corporate leaders, has fueled a gold rush mentality to create new learning opportunities for students, both in school and out of school, for coding. For example, a recent online search for "coding programs for kids" yielded over 32 million websites.* And whereas 71% of school and district administrators say that they have incorporated some type of coding education into their school curriculum, most of those experiences are either once-a-year "all school coding days" or after-school programs for students who select to participate.

While these efforts are laudable for driving awareness and/or meeting the needs of selected students, they are insufficient in creating an optimum environment for preparing all of today's students to be successful in the future. Rather, educators agree that there are three essential conditions for optimizing coding as a futureready learning experience:

1. Just as it is imperative that all students develop skills they will need to contribute and compete in a global society and economy, it is also imperative that all students develop a fluency in coding, computer programming, or computational thinking. For this to happen, coding experiences must be integrated into daily instruction and across all subjects so that all children gain the benefits, not just students who have out-of-school access to such resources. To level the playing field so that all students have the opportunity to develop these skills, we need tools that enable any teacher, not just those with comfort or background in computer programming, to introduce coding easily and efficiently within their general education curriculum.

2. Coding experiences have the potential to help students develop creativity skills and become creators of content, not just consumers. However, that process is highly dependent upon the type of coding experience. Are our students learning coding skills that enable them to creatively solve a real-world problem and ignite a passion for inventing innovative solutions?

3. For coding programs to become seamlessly interwoven into classroom instruction, it is essential that we understand what teachers need to become comfortable in this new learning environment, and how to help them develop their own capacities for new skill development. This will enable teachers to not only support creative coding experiences in their classrooms but to empower their students to see themselves as creators and inventors of new paths to solving problems. A scaffolded approach with extensive teacher support resources has the potential to truly transform the way teachers approach coding across the curriculum.

This executive brief, a collaboration between BrainPOP® and Project Tomorrow®, examines all three of these essential conditions for creating an optimum environment for creative coding. Leveraging timely findings from Project Tomorrow's Speak Up Research Project, as well as interviews with administrators and teachers who are on the front lines of integrating coding within classroom instruction, we consider the importance of workplace skills development, notably creativity, in education today, the state of coding experiences in schools, and the role of such learning experiences to empower a new generation of creators. It is our hope that this in-depth analysis will help school and district leaders understand how to embed within their schools a new cultural understanding of coding as a language of creativity, as so aptly identified by Dr. Klawe.

*Google search conducted on October 15, 2018 https://www.google.com/search?rlz=1C2AZAA_

SUMMERY

A summary of the key findings from this analysis include the following:

- Three-quarters of parents of school-aged children (74%) identify creativity as an important skill for their child to develop in school to be successful in the future.
- Parents and school district leaders see coding as a good way for students to develop creativity skills.
- Students agree as well–58% of students in grades 6-8 say the most important reason to incorporate coding within the school day is to help them develop creativity skills.
- Student interest in learning coding transcends gender, grade level, community type and home poverty, and that interest is growing–middle school student interest in learning coding increased by 23% in just three years.
- Teachers need easy-to-use tools and classroom support resources to effectively integrate coding as a new form of creative expression across their curriculum.

IMPORTANCE OF CREATIVITY SKILL DEVELOPMENT FOR ALL STUDENTS

According to a 2016 report from the World Economic Forum, by 2020 creativity will be the third most important workplace skill desired by companies, closely following problem solving and critical thinking.** What is especially noteworthy is that in 2015, creativity ranked 10th on the World Economic Forum list. This increased emphasis by global employers on creativity as an essential workplace skill is echoed by education experts as well. Sir Ken Robinson admonishes the education community to think differently about creativity:

> **"Creativity is as important now in education as literacy and we should treat it with the same status."***

Given that parents are increasingly concerned that their child is not learning the right skills in school to be successful beyond graduation, it is noteworthy that three-quarters of parents of school-aged children (74%) identify creativity as a top five "right skill" for their child to develop while in school (Table 1).

Table 1: What College and Workplace Skills are Most Important for Your Child to Develop in School to Be Successful In the Future?

Skills	Parents Who Agree
Critical thinking and problem solving	87%
Teamwork and collaboration	77%
Ability to work with diverse groups of people	76%
Technology skills	75%
Creativity and out-of-the-box thinking	74%

**https://www.weforum.org/reports/the-future-of-jobs

***https://www.ted.com/talks/ken_robinson_says_schools_kill_creativity?language=en

Creativity is equally valued by parents of children in every grade from kindergarten through high school. Parents in rural communities (73%), urban communities (73%), and low-income communities (74%) have the same level of support for creativity as an important skill as parents in suburban or more affluent communities (74%). School district administrators (74%) also identify creativity in their top five list of the most important college and workplace skills for student development. Like parents, district leaders also connect critical thinking, teamwork, ability to work with diverse groups of people, and technology proficiencies as essential skills as well.

Beyond the rhetoric however, it is sometimes difficult for teachers to understand how to create meaningful learning experiences in their classroom that support creativity skill development. Quite often that has to do with a hesitancy to allow students to make their own choices within the learning process. Only 23% of teachers say they are very comfortable with students having choice in their classroom.

Steve Isaacs, a teacher at William Annin Middle School in Basking Ridge, NJ, however, endorses student choice to not only help his students develop their creativity muscles in an organic way, but also as a way to teach them about how to learn. Mr. Isaacs uses coding around game development as a medium for his students to develop these skills. Most importantly however, he provides ample opportunities within these coding experiences for his students to self-direct their learning.

"When they start creating, I want my students to have choices as to what tools they use and to take learning into their own hands. Even when I guide them through something, they need to take ownership to make the game their own. This is really about teaching kids about how to learn, not just about how to make something based upon my instructions."

Echoing that ancient Chinese proverb, students in Mr. Isaacs' class develop a confidence and comfort with their own creativity because he involves them in the process of structuring their own learning.

Echoing that same approach, Allisyn Levy, Vice President, Product Lead at BrainPOP, describes creativity as allowing students to "show what they know" using tools that they choose themselves. That philosophy, which is the foundation for BrainPOP's Make-a-Map and Make-a-Movie tools, is also at the center of the company's new Creative Coding solutions for schools. As Ms. Levy explains, "The open-endedness of using tools like these within all subject areas allows students to be successful in demonstrating what they have learned whatever their strengths. The students' (and teachers') comfort and familiarity with BrainPOP supports an easy transition into effective classroom integration."

LEVERAGING CODING EXPERIENCES TO HELP STUDENTS DEVELOP CREATIVITY

Like Steve Isaacs and many other teachers, parents and district leaders are interested in the relationship between creativity skill development and classroom coding experiences. Both stakeholder groups see coding as a high-impact way for students to exercise and develop their creativity muscles. Notably, within the past four years, the percentage of parents who identify coding as a good way to develop workplace skills has increased dramatically from 28% in 2014 to 45% in 2018. Parents of elementary-aged children have the greatest interest in coding learning experiences for their children–49% of parents with children in grades K-5. Overall though, across all community types and various levels of family income, parents endorse coding for their children.

A majority of district administrators nationwide (52%) identify closing the achievement gap as a top priority for their schools. When asked to identify best approaches for addressing the achievement gap, district leaders point to the integration of college and career-ready skill development within the everyday curriculum. Holding that position, it makes sense that district leaders also value classroom coding experiences. The intensity of that support for coding varies by community type and district level position. Within large school districts with student populations over 25,000, 51% of district leaders say coding is the best way for students to develop workplace skills. Chief Technology Officers (63%) are also particularly bullish on coding for all students.

While there is a high level of agreement on the value of coding for all students by parents and educators, the motivations or benefits of coding for students vary by stakeholder group. For parents, community members, and administrators, the primary benefit is the opportunity for students to develop critical thinking skills (Table 2). For students, coding equals creativity skill development pure and simple. A majority of students in both middle school (58%) and high school (51%) identify creativity as the most significant reason why a school should offer coding experiences for their students. Interestingly, two-thirds of school principals (65%) on the front lines of implementing coding within their curriculum agree as well.

*Google search conducted on October 15, 2018 https://www.google.com/search?rlz=1C2AZAA_

Table 2: Why It Is Important for Schools to Provide Coding Learning Experiences for Students

Because students will	Students in Grades 6-8 Who Agree	Parents Who Agree	Community Members Who Agree	School Principals Who Agree	District Admins Who Agree
Develop creativity skills	58%	46%	48%	65%	50%
Learn how computers work	51%	51%	45%	47%	28%
Develop critical thinking skills	49%	63%	63%	78%	77%
Be prepared for programming jobs	45%	53%	52%	59%	39%
Solve real-world problems	38%	43%	43%	68%	65%

K-8 students regularly equate the use of technology with supporting creativity skill development. This often surprises adults who assume that students place a higher premium on engagement than skill development. Parents and educators are also surprised by students' high interest in having meaningful coding experiences built into their daily instruction. Educators' lack of appreciation for students' desire to learn coding may be a contributing factor for why so few students–only 7% in kindergarten through 8th grade—report that they are learning coding within regular classroom instruction.

Students' interest in learning coding continues to grow year over year. The percentage of middle school students interested in participating in coding learning experiences increased by 23% in just three years. This unmet demand for coding in elementary and middle schools is not limited to affluent, suburban communities either. Students from all types of communities and family backgrounds want to learn coding as the means to developing their creativity skills and improving their preparation for future success. And again, sometimes surprising to adults, this applies to girls as well as boys (Table 3).

Table 2: Why It Is Important for Schools to Provide Coding Learning Experiences for Students

Student Sub-Groups	% Who Say They are Interested in Learning How to Code in School	% Who Say They are Already Doing This In School
Girls Grades K-5	50%	6%
Boys Grades K-5	60%	7%
Girls Grades 6-8	60%	5%
Boys Grades 6-8	69%	8%
Grade K-5 Students in Title 1 Schools	58%	6%
Grade 6-8 Students in Title 1 Schools	67%	7%
Grade K-5 Students in Rural Communities	58%	5%
Grade 6-8 Students in Rural Communities	63%	6%

The universality of the student interest in coding is very evident for teachers who have incorporated coding into their curriculum or in schools that offer such programs to their students. Stereotypes about "coders" go by the wayside when the curriculum is built around solving real world problems and creating many different types of content using coding techniques.

Chris Schilling, a 6th- and 7th-grade teacher at the Quest to Learn School in New York City, observes this every day.

All profiles of students are succeeding with coding at our school. We definitely see way more girls in our coding population. We also have kids who are really way above grade level, kids right at grade level, and kids who struggle academically. The common denominator is that they are all really excelling in coding. They are passionate about it and it shows in their success.

Recognizing student interest in coding is the first step to building a new culture for creative coding at every school, so that every child can develop this new language of creativity.

BUILDING NEW SCHOOL CULTURES FOR CREATIVE CODING FOR ALL STUDENTS

Countering the popular perception that coding is only about addressing the workforce needs of the technology industry, Professor Karen Brennan from Harvard's School of Education explains, "This is not about wanting everyone to become a computer scientist. Just like the ability to read, it's about computational fluency for everyone, and the ability to think and create."

Consequently, a mind shift is necessary to think beyond coding as a skill in itself and to realize that learning to code is a process for students to develop creativity skills by actually developing solutions to problems or challenges. Just as we have learned from constructivism, the more connected that development process is to the real world and students' experiences, the more engaged the students will be in the learning process.

To create a new school culture for creative coding, it is necessary to think about the new approaches to instruction and what teachers need to embrace this new culture and mindset.

Relative to understanding the fundamental differences between traditional instruction and creative coding, Whitney Logan from Waterford Public Schools in Connecticut explains it this way:

"Sometimes it is really hard for students to be creative in an academic environment because they are worried about being right. I think it is important especially in math class that students feel secure in themselves, but that they can also be creative and persevere through difficult challenges. The point is not to learn how to code necessarily but to think outside the box as to how you are going to solve a problem. I think coding helps students develop perseverance because it is so highly motivating. The students keep trying to find new ways to make it work and that is the heart of being creative."[†]

This new approach, which incorporates coding as a means of creative expression in any subject area, is a cornerstone of BrainPOP's Creative Coding solution. Prior to her position with BrainPOP, Ms. Levy was a classroom teacher. In her work helping teachers learn how to use new BrainPOP tools, she often relies upon her own teaching experiences to paint a descriptive picture of the classroom experience. Such is the case when thinking about how to think about the creativity tools, including coding, within a curricular unit.

"For example, if I am doing a classroom unit with my 4th graders on presidential elections, we are probably using all kinds of different instructional activities including reading books, doing research, playing games, and doing role plays. It is equally important for me that my students demonstrate what they have learned from that unit in a way that is personal for them, in a way that allows them to contextualize that knowledge in a creative way. With the BrainPOP suite of creativity tools, I can provide my students with a challenge to create a presentation to teach other students what they have learned using Make-a-Movie, Make-a-Map or Creative Coding. The choice of tool is in the hands of the student and that by itself is empowering. For the teacher, the BrainPOP suite allows a unique opportunity to incorporate high-impact content creation tools conceptually within any curricular unit. And it provides a more meaningful and engaging alternative to doing slides shows or posters."

[†] https://news.harvard.edu/gazette/story/2014/11/coding-and-creativity/

To embrace this new mindset valuing student choice and perseverance in the quest for developing creativity, teachers need to be comfortable with a more open environment in the classroom that follows the learner's path, not necessarily the teachers' guided instruction manual. Creative coding learning experiences can provide teachers with the scaffolding they need to incorporate this type of organic learning within their classroom.

But teacher educators such as Matt Farber from the University of Northern Colorado caution that too often, coding programs end up focused on purely operational tasks (get your character to turn right or left) when the real learning should focus on "an iterative design process, thinking about systems, thinking about thinking, thinking about the impact of your design and solution on your end user, real or imagined."

Dr. Farber explains that if "every child programmed a math game, even if it was a terrible math game, they would gain deep knowledge of content by creating and designing this interactive system through a process that empowers them as the learner in charge of that process."

By providing these types of learning experiences for his pre-service teachers, Dr. Farber is certainly paying it forward to support the effective use of creative coding programs in the future K-8 classrooms of his students. But ultimately, as Dr. Farber acknowledges, this discussion is about equity of learning opportunities for all students. Access to creative coding learning experiences that help students develop important college and career ready skills should be the right of every child today. It is imperative that our nation's schools embrace this new mindset about learning and empower coding for all students across the school curriculum.

ENDING THOUGHTS AND CALL TO ACTION

Within society today, there is seemingly universal agreement about the value of students acquiring fluency in coding, computer programming, or computational thinking as part of that preparation for a successful future. This position, shared by parents and principals, college professors, and corporate leaders, has fueled a gold rush mentality to create new learning opportunities for students, both in school and out of school, for coding. While those efforts are notable for creating awareness of coding, many are insufficient for addressing the equity considerations or helping students develop creativity skills. As documented in this executive brief from BrainPOP and Project Tomorrow, it is important for school and district leaders to recognize that there are three essential conditions for optimizing coding as a future-ready learning experience:

1. To provide equitable access to coding experiences for all students, coding should be integrated throughout the curriculum, across all subject areas, as a part of daily instruction.
2. Coding is the new language of creativity and as such, the focus should be on leveraging coding to support creative expression and providing a way for students to demonstrate what they have learned, not about simply making a character move left or right.
3. Teachers are the key to the effective integration of coding across the curriculum, but teachers need the right tools and support to feel comfortable and be effective with these new instructional goals.

Moving beyond general awareness of coding as a workplace skill requires a new mindset within schools. In this executive brief, our goal was to provide new research findings and experiential insights to inform that growth mindset process within schools and districts. To further support that effort, we suggest that education leaders engage in new discussions within their school communities to explore new approaches and solutions. The following discussion questions can be a good starting point for those discussions:

- How effectively are your schools addressing the views of students and parents that coding helps students develop creativity skills?
- What is next after your students develop general awareness of coding through a once-a-year experience?
- Are you providing equitable learning experiences for students to experience content creation through coding or are your coding experiences only available to certain students?
- How do you develop a new mindset within your school teams that coding is the new language of creativity, and not just a workforce preparation skill?
- What support do your teachers need to easily and effectively integrate coding tools within every subject, every curricular unit?
- How are you empowering choices and options for your students to show what they know in a way that leverages their strengths as well as their passion for what they are learning?

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ABOUT PROJECT TOMORROW

Project Tomorrow is a global education non-profit organization dedicated to the empowerment of student voices in education. With 22 years of experience in education, Project Tomorrow regularly provides consulting and research support around key trends in K-12 science, math, and technology education to school districts, government agencies, business, and higher education.

The Speak Up Research Project annually polls K-12 students, parents, educators and community members about the impact of digital tools, content, and resources on students' learning experiences both in school and out of school, and represents the largest collection of authentic, unfiltered stakeholder voice on digital learning. Since 2003, over 5.7 million K-12 students, parents, teachers, librarians, principals, technology leaders, district administrators and members of the community have shared their views and ideas through the Speak Up Project. For more information visit: http://www.tomorrow.org

ABOUT BrainPOP

BrainPOP (www.brainpop.com) is an award-winning educational platform that offers cross-curricular digital content from animated movies, coding projects, student creation and reflection tools, learning games, and interactive quizzes to customizable and playful assessments, lesson plans, professional development opportunities, and beyond. Teachers can assign work, provide feedback, and keep track of learning overall. Ideal for classrooms, home, and mobile devices and individual, team, or whole-class learning, our resources include BrainPOP Jr. (K-3), BrainPOP (available in English, Spanish, Mandarin, and French), and, for English language learners, BrainPOP ELL. We're used in a third of U.S. elementary and middle schools and welcome millions of monthly site visitors; our award-winning apps regularly rank among the highest in the major app stores' education categories.