

STEM for All: Teens Teach Kids Coding

<https://aigolearning.org/stem4all/>

I. Executive summary

We propose to engage VISTA to help communities in need by creating a volunteer recruitment and management system in which high school and college students will be trained to teach online project-based STEM coding courses to children from age 5 – 15, to help children improve their digital literacy as well as their coding abilities.

II. Need

1. Economic and racial inequity

The inequities are well documented in government reports and by community findings. Here are some of the data to illustrate:

1.1 Poverty:

- 1) The U.S. poverty rate in 2019 was 10.5 percent. There were 34.0 million people in poverty. Poverty rates for children under 18 was 14.4%. [1] As of July 2019, the poverty rates in Trenton (Mercer County) and New Brunswick (Middlesex County) are 28.4% and 34.2%, respectively. [2]
- 2) Concentrated poverty has been on the rise in New Jersey in the last two decades, as is nationally. In 2000, New Jersey had 110 high-poverty neighborhoods, representing 5.7% of all tracts in the state. In 2012, there were 134, or 6.7% of all tracts. By 2018, that number had risen to 145, or 7.2% of the total number of neighborhoods. This neighborhood poverty is persistent. From 2012 to 2018, 89 neighborhoods started out high-poverty and stayed that way. [3]

1.2. Unemployment: The latest U.S. unemployment rate is 6.9 percent as reported. In August 2020, the unemployment rate in the City of Trenton stood at 8.7% (18,047 individuals). [4]

1.3 Racial Inequity:

- 1) In 2019 the poverty rate was 9.1% for whites, compared to 15.7% for Hispanic Americans and 18.8% for African Americans. [1] African-American children are three times as likely to be poor as white children. [5]
- 2) In New Jersey, majority-Black neighborhoods are much more likely to have poverty rates above 30% than is statewide, with 33.2% of majority-Black neighborhoods also qualifying as high-poverty, compared to only 7.2% of all tracts. Similarly, 23.9% of majority-Hispanic neighborhoods are also high-poverty. Of all 145 high-poverty neighborhoods in 2018, 42.8% were majority-Black and 35.9% were majority-Hispanic, while the total state population is only 12.7% Black and 19.9% Hispanic. [3]

- 3) African-American workers typically have a higher rate of unemployment than their white college-educated counterparts. From November 2018 to October 2019, the Black college graduates' unemployment rate averaged 40 percent higher than for white college graduates in the same period. [6]
- 4) African-American workers typically get paid a great deal less than white workers. The typical median weekly earnings for Black full-time employees was \$727 from July 2019 to September 2019, compared with \$943 for whites. [6]

1.4 Underrepresented groups in STEM education and STEM jobs:

- 1) 2015-2016 In U.S. public schools, African-American students make up 17% of the overall 8th grade enrollment, but only 11% of those enrolled in algebra 1. Latinos made up 25% of the overall enrollment but only 18% of those taking algebra 1. [7]
- 2) Forbes Magazine reported, "Women hold nearly half of all jobs in the U.S., but less than 25 percent of all STEM jobs." [8]
- 3) African-American workers make up 11% of the U.S. workforce overall but represent 9% of STEM workers, while Hispanics comprise 16% of the U.S. workforce but only 7% of all STEM workers. [9]

2. The world is changing

Why are the needs not being met now? With technology advancing, the job situation is tilted to people with STEM and coding skills.

2.1 Jobs are changing. On Nov 24, 2020, MIT's Work of the Future Task Force published a 92-page report on technology and the labor force. The two and half years research found that future demand for workers is to know technology. [10]

2.2 STEM is important (for job). Employer demand for STEM qualifications and skills is high. [4]. STEM jobs are in-demand high-paying jobs. The wage for STEM jobs is about 70% more than the national average. [11]

2.3 Coding is important (for job). A child who learns how to code will have the advantage in life with more employment opportunities available to them in the future, no matter which industry they decide to enter. Since 1990, STEM employment has grown

79% (9.7 million to 17.3 million) and computer jobs have seen a whopping 338% increase over the same period.[9]

The truth is, an education to coding is fundamental for all 21st-century students, especially for economically and racially disadvantaged children. Coding is a tool to improve educational equity. It is a means of bridging the digital divide. Without coding, many students in lower socioeconomic communities will miss the opportunities that coding brings.

3. STEM for All : Teens Teach Kids Coding (TTKC) initiative

We propose to engage VISTA to create a volunteer recruitment and management system in which recruited high school and college student-volunteers will teach online project-based STEM coding courses to children ages 5 – 15 years old from low-income families, for 45 - 90 minutes a day after school or weekend, 1-2 times per week.

Our STEM for All: TTKC initiative proposes a 3-4 years project to focus on issues in education, teach STEM coding courses for economically and racially disadvantaged students using remote learning technology. We start with students in areas of concentrated poverty, possibly replicate to more states, and to rural communities. We will also partner with research institutes for longitudinal research at the same time. We will serve students in ages of 5-15 years old in title 1 schools in New Jersey, starting from the schools in Trenton and New Brunswick. [12]

As a result of learning to code, the students will build interest in STEM particularly in computer science, improving their coding skills. Being able to read and write code is the new 21st century literacy. Students will improve in Critical thinking and Problem solving, Creativity, Communication, Teamwork and collaboration, and their Academics.

Number of research indicate that teaching coding to students in preschool [13], [14], Kindergarten [15], first grade [16], second grade [15], 5th Grade [17], or participants aged 8–17 years old [18], lead to improvements in engagement, academics, and behavior [19].

4. Measure the success

As Congressman John Lewis, a former Associate Director of ACTION said “Change often takes time. It rarely happens all at once. “. STEM for ALL: TTKC initiative aims for the long-term goal of Anti-Poverty and Sustainable Solutions.

The impact of the program on communities will be reflected in the following ways:

- 1) Improve student’s interest in computer science, general in STEM and artificial intelligence.
- 2) Increase student’s enrollment in computer science and math courses, academically.
- 3) Increase student’s enrollment in STEM activities such as Hackathon coding competition

Intervention effectiveness can be measured through assessments, i.e. individual’s skill-building progress is measured through online pre- and post-assessments specifically designed to measure proficiency in the Digital Literacy/Coding standards. Our initiative also aims for youth development. Student teachers from high schools and colleges will benefit from volunteering in teaching and other activities. Students who take courses, can become the teacher assistants or teachers, becoming an active alumni group.

III. Strengthening Communities

1. STEM for All: TTKC initiative builds long-term sustainability through five innovations:

1.1 Our core student teachers training program

The core of any education program lies in the teachers. There are limitless STEM resources out there, particularly online, but the **STEM teachers shortage** is the biggest challenge to getting computer science into the students! [20] [21][22][23] We approach the challenge by involving high school and college students. By taking advantage of the maturity of remote learning technology and the abundance of virtual classes, caused by the fact that the pandemic necessitated online education, teachers can host classes from anywhere and students can attend classes from anywhere. The sky is the limit. [24]

Our past classes have proven that not only can we manage student teachers, but also train them to teach students. This basically ensures that there are sufficient teachers available for the initiative.

- 1) High school students can teach coding because of the following factors.
 - a) Coding is fun. Learning coding is made fun for children through the use of easy yet helpful programming platforms. [25]
 - b) Not only are many high school and college students knowledgeable in computer programming but also are capable of teaching it.
 - c) Each class will follow a project-based curriculum that focuses on “making” projects, which easily allows student teachers to take over while ensuring that the class is both engaging and enjoyable.
 - d) Having student teachers creates a sibling like relationship between the student and teacher, helping to break a rigid classroom structure. [26]
- 2) High school/College students want to teach because as result of learning to teach, high school and college students are beneficial in the following areas:
 - a) Share their knowledge to serve the community.
 - b) Grow their learning as they teach. [27] [28]
 - c) Gain real-world working experience.

- d) Skill building. Teaching helps develop essential social-emotional skills in efficacy, confidence, communication, responsibility and leadership.
- e) College preparation (for High school students). Earn volunteering credits
- f) Make a stipend. Students who want to earn a side “income”.

1.2 Our cohesive systemic curriculum

We weave a comprehensive Project-based learning (PBL) curriculum with a series of different coding course at different ages:

- 1) Preschool and Kindergarten: Learning from Mistakes and Problem Solving
- 2) Elementary School: Creativity
- 3) Middle School: Algorithmic, Computational and Sequential Thinking
- 4) High School and Beyond: Mastering of Coding Skills

TTKC initiative exposes students to STEM routinely. This exposure begins with the earliest learning experiences and continues throughout their K-12 years, not just once, but many times and in many ways. A greater number and variety of exposure opportunities leads to stronger outcomes.

Furthermore, the students learned and grown in our system can stay in the system. They become teachers, to teach the next rounds of young children.

1.3 We collaborate with communities

We engage families and educate them about the benefits of STEM

- 1) We nurture relationships and communications with the families. Research found that to Hook Students on STEM, start With Their Parents, the community. [29]
- 2) Utilize community resources such as inviting leaders in the community to give presentations to the teachers in order to increase their knowledge of teaching. We are also looking for a partnership to develop a teacher certificate program.
- 3) Host Hackathon coding competition for children. We had the first TTK Hackathon coding competition on Sept.19-20, 2020. It was one of the few hackathon events in the country that specifically holds a competition on Scratch for Children. [30]
- 4) We engage local government agents (education board, schools) and nonprofit groups

1.4 Our teaching and learning platform

Our web-based school platform connects teachers, students, parents and schools, to enable interaction and efficiency. It streamlines the process for recruitment, training, teaching, class management. This improves user experience and keeps resources down.

1.5 Hybrid business model

We design the class as paid students mixed with students who take free lessons. In that way, to make the class affordable (free) and keep the high-quality teaching.

2. We request 5 VISTAs, who will help connect the dots, in the following roles:

- 1) 1 Marketing, outreach manager (and contact persons) - Reach out to communities (board of education), schools (title 1); nonprofit organizations (colleges too), corporations; parents, PTAs.
- 2) 1 Sales, sales manager (and sales persons) - Reach out to after-school programs and Learning centers.
- 3) 1 Design and digital content creation, branding manager and designers - Create branding content.
- 4) 1 Media, social media manager (digital media too) - Promote in media.
- 5) 1 Recruiting and volunteers management, HR manager - Recruit high school students and recruit college students.

Over time as the VISTAs implement the project and build capacity. they can all be replaced by students, and the model itself is sustainable.

IV. Organizational Capability

Aigolearning has experience in running AI coding classes for children. TeensTeachKids, the program started as a result of the shift to virtual learning, is growing. Over the last three months, we have recruited and trained over 100 student teachers as well as taught four distinct programming courses to over 300 children aged 5 to 14. Both the teachers and students come from states across the country and are of diverse ethnicities. Additional teachers and students are signing up for this program every week.

1. Engage community partners with the project and their roles

Aigolearning will engage with multiple local communities partners, including:

1.1 Education of board: Involve in planning, developing, implementing, and evaluating the project. Contact with inherent community assets and resources, such as connecting with local schools

1.2 Title 1 Schools: connect with low-income students

1.3 PTAs (Parents): Engage the parents to encourage their HS child to teach; encourage the parents to enroll their young child in coding class.

1.4 Non-profit organizations (i.e. Huaxia Chinese schools, AAPSG)

1.5 Colleges: College students (career development office) for volunteers, and research collaboration on STEM education.

2. Project management, to recruit and supervise the VISTA member(s).

Aigolearning will be operating in the following way:

2.1 The team is student-run with supervision under adult advisors. The team consists of President, vp, secretary, treasurer, and 4 special committee of 1) Training; 2) Marketing/Sales; 3) Class Management; 4) Curriculum Development.

2.2 Process for student teaching and student enrollment

- 1) Volunteers HS/college Students sign-up form -> training -> evaluation
-> (teacher/TA pools) assign to class as TA (time sheet) -> Teacher (time sheet)

- 2) Parents fill out Student sign-up form -> assign to class -> notified to class online (must have computer, internet, sign video/picture agreement form)

2.3 An online CMS platform for training/teaching/learning and class management before, during and after the class.

- 1) Recruitment through College career office, job site such as Handshake.com, and education board/schools/PTA
- 2) Supervision focuses on (remotely) performance-driven data including number of teachers, number of students, feedback from schools/parents/students and teaching quality control.

3. Since our entire team works remotely, there is no need for office and desk space, just computer / internet and phone, which almost everyone has. Video conference for online class is available for free in both ZOOM and google classroom.

References

- [1] Income and Poverty in the United States: 2019.
<https://www.census.gov/newsroom/press-releases/2020/income-poverty.html>
- [2] United States Census Bureau <<https://www.census.gov/quickfacts/>>
- [3] The Geography of Poverty and Race in New Jersey | New Jersey Future (njfuture.org) October 2020. <https://www.njfuture.org/wp-content/uploads/2020/10/The-Geography-of-Poverty-and-Race-in-New-Jersey-Oct-2020.pdf>
- [4] U.S. Bureau of Labor Statistics <<https://www.bls.gov/>>
- [5] Ratcliffe, C. (September 2015). Child Poverty and Adult Success. Washington, D.C.: Urban Institute. Retrieved from
<https://www.urban.org/sites/default/files/publication/65766/2000369-Child-Poverty-and-Adult-Success.pdf>
- [6] Center for American Progress
<https://www.americanprogress.org/issues/economy/reports/2019/12/05/478150/african-americans-face-systematic-obstacles-getting-good-jobs/>
- [7] 2015-16 Civil Rights Data Collection survey of U.S. public schools.
<https://www2.ed.gov/about/offices/list/ocr/docs/stem-course-taking.pdf>
- [8] Forbes Magazine How STEM Education Inspires Kids, Educators To Act Locally, Think Globally. <https://www.forbes.com/sites/samsung/2014/01/20/how-stem-education-inspires-kids-educators-to-act-locally-think-globally/?sh=5379640c58a5>
- [9] Pew Research Center Diversity in the STEM workforce varies widely across jobs.
<https://www.pewsocialtrends.org/2018/01/09/diversity-in-the-stem-workforce-varies-widely-across-jobs/>
- [10] The Work of the Future: Building Better Jobs in an Age of Intelligent Machines.
<http://workofthefuture.mit.edu/wp-content/uploads/2020/11/2020-Final-Report2.pdf>
- [11] Smithsonian Science Education Center. (2018). The STEM Imperative. Retrieved from <https://ssec.si.edu/stem-imperative>
- [12] Title I - Schoolwide Programs - NJ.gov <<https://www.state.nj.us/education/title1/>>

[13] The effect of coding courses on the cognitive abilities and problem-solving skills of 4-5 years old preschool children.

<https://www.tandfonline.com/doi/abs/10.1080/08993408.2019.1696169?scroll=top&needAccess=true&journalCode=ncse20&>

[14] The Roots of STEM Success. <https://bayareadiscoverymuseum.org/research-resources/publications>

[15] What they learn when they learn coding: investigating cognitive domains and computer programming knowledge in young children.

https://sites.tufts.edu/devtech/files/2019/09/Strawhacker_et_al-2019-Educational_Technology_Research_and_Development-2.pdf

[16] The effects of coding on children's planning and inhibition skills.

https://www.researchgate.net/publication/338450597_The_effects_of_coding_on_children's_planning_and_inhibition_skills

[17] The Effects of Coding Integration on Student Engagement and Academic Achievement in a 5th Grade Mathematics Class.

<https://sophia.stkate.edu/cgi/viewcontent.cgi?article=1303&context=maed>

[18] Exploring children's learning experience in constructionism-based coding activities through design-based research.

<https://www.sciencedirect.com/science/article/pii/S0747563219300184>

[19] Coding in K-8: International Trends in Computing Education with Primary-aged Children. https://www.researchgate.net/publication/318470729_Coding_in_K-8_International_Trends_in_Computing_Education_with_Primary-aged_Children

[20] “how we create an all-hands-on-deck approach to science, technology, engineering, and math... ..We need to make this a priority to train an army of new teachers in these subject areas...” Remarks by President Barack Obama at the 2013 White House Science Fair. <https://obamawhitehouse.archives.gov/the-press-office/2013/04/22/remarks-president-2013-white-house-science-fair>

[21] ‘Self-directed learning’ skills are key to making remote instruction work

<https://hechingerreport.org/self-directed-learning-skills-are-key-to-making-remote-instruction-work/>

[22] While some students thrived during the coronavirus-inspired spring of remote learning, educators, parents and students themselves have reported frighteningly low engagement. Among 20,000 middle and high school students surveyed by Youth Truth, a national nonprofit research organization, just 41 percent of them said they could motivate themselves to do schoolwork while their school buildings were closed.

[23] The effectiveness of self-directed learning vs. teacher-led learning on gifted and talented vs. non-gifted and talented students.

https://www.researchgate.net/publication/320831845_The_effectiveness_of_self-directed_learning_vs_teacher-led_learning_on_gifted_and_talented_vs_non-gifted_and_talented_students

[24] Number of educational institutions exist in the United States.

<https://nces.ed.gov/fastfacts/display.asp?id=84>

[25] The Effects of Teaching Programming via Scratch on Problem Solving Skills

[https://www.semanticscholar.org/paper/The-Effects-of-Teaching-Programming-via-Scratch-on-Kalelioglu-](https://www.semanticscholar.org/paper/The-Effects-of-Teaching-Programming-via-Scratch-on-Kalelioglu-G%C3%BClbahar/a3ffe77513b6e5bb078290873c84f353c1ab6542?p2df)

[G%C3%BClbahar/a3ffe77513b6e5bb078290873c84f353c1ab6542?p2df](https://www.semanticscholar.org/paper/The-Effects-of-Teaching-Programming-via-Scratch-on-Kalelioglu-G%C3%BClbahar/a3ffe77513b6e5bb078290873c84f353c1ab6542?p2df)

[26] Pathway Service-Learning Tutoring Program.

<https://education.sdsu.edu/pci/pathways>

[27] Learning to teach, teaching to learn

<https://www.apa.org/gradpsych/2006/03/cover-teach>

[28] Learning by teaching others is extremely effective

<https://digest.bps.org.uk/2018/05/04/learning-by-teaching-others-is-extremely-effective-a-new-study-tested-a-key-reason-why/>

[29] To Hook Students on STEM, Start With Their Parents.

<https://www.edweek.org/ew/articles/2018/05/23/to-hook-students-on-stem-start-with.html?cmp=eml-enl-eu-news2&M=58500585&U=2733377>

[30] TTK Hackathon 2020 Coding Competition. September 19-20, 2020.

<https://aigolearning.org/hackathon2020>