Micro:bit Proposal

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Body

Problem and Need

The United States is falling behind in STEM education. The Director of the Institute for Genome Sciences at the University of Maryland, Claire Fraser, PhD, warns that “We now have to come to grips with the fact that the world is changing and changing rapidly … interventions to promote, boost, and encourage students to move into STEM education and careers must start at the K-12 phase”(Morrison, 2022).

A biennial report on science and engineering indicators by the National Science Foundation corroborated these concerns. Although advancement is being made, the report concluded that the US is falling behind compared to other countries according to every major measure as the US share of activity in these areas has remained stagnant or shrunk. Developing countries, like China and India, have rapidly advanced to take up a much larger share of activity in these areas. This all occurs against a backdrop where women and minority groups continue to be underrepresented in these areas in the US (Khan et al, 2020).

The Institute for Education Sciences cites a lack of STEM “identity” as a main reason why young people don’t pursue STEM. This is a lack of confidence, a lack of role models, a lack of understanding of the value of STEM, and a lack of opportunities to learn. These problems apply to historically underrepresented groups the most. After school programs give students from all different backgrounds opportunities to build these skills and interests.

Universities in the US are struggling to keep up with rapidly increasing numbers of students in Computer Science and Computer Engineering. Many of these students have no experience in Computer Science or Engineering from their K-12 education. With only 5% of public high schools certified to teach AP Computer Science and only 25% of public schools teaching programming, there is room for improvement (Steed, 2021).

A study by the International Journal of STEM Education examined the effects of extracurricular STEM programs and found that “most youth (65%-85%) reported increases in STEM engagement, identity, career interest, career knowledge, relationships, critical thinking, and perseverance, with the largest gains reported by those engaging with STEM activities for 4 weeks or more”(Allen, 2019). The study also found that students participating in higher-quality STEM programs reported more growth than students in lower-quality programs. Another study found that "students' participation in OST activities was associated with a greater likelihood of indicating career interest in STEM while in university by a factor of 1.5" and this effect applies roughly the same for males and females.

Many students, especially girls and members of historically marginalized groups, miss the opportunity to learn about and collaborate over STEM activities at a young age. This negatively impacts their likelihood of pursuing STEM or related fields into adulthood. These missed opportunities would have steered more young people towards STEM fields as they would have learned to appreciate STEM and the benefits it provides to the world. They also lack role models that enable them to see themselves and their potential to succeed with confidence. As the US struggles to keep pace with the rest of the world in science and technology, it has become more important than ever before to promote STEM education to youth in a fun and collaborative environment.

The federal government and private businesses have made efforts to direct funding towards programs that encourage youth to pursue STEM, yet many schools lack this kind of programming in-class or after school. Many school districts in Oregon lack these programs and the benefits they bring. The Lafayette community is one such district that could benefit from after school STEM programs.

(Placeholder for Wascher elementary school level need data, TBD)

The most central location for youth in the Lafayette community is the elementary school, Wascher Elementary. The aim of this project proposal is to provide an after school technology program to 4th and 5th graders. For the 2020-2021 school year there were 56 4th grade students and 66 5th grade students. An initial participation goal for the program is 10% of age-appropriate students. There are 2 candidate locations within the school that will provide accommodation for a group of 20 people or larger, the cafeteria or the library. The library is the recommended choice for this project, the project tables are smaller and more applicable to small group work than the large expansive tables of the cafeteria.

Proposed Solution

There seems to be no shortage of empirical data showing that children from underserved communities who have less access to the internet and technology are at a long-term economic disadvantage compared to students who do have access to these tools. Our proposed solution takes a two-tiered approach.

Improve Digital Readiness

The first being to improve digital readiness. Sometimes digital readiness is synonymous with " The Digital Divide " which is " the gap between those who have affordable access, shills, and support to effectively engage online and those who do not. This divide prevents equal participation and opportunity in all parts of life, disproportionately affecting people of color, Indigenous peoples, households with low incomes, people with disabilities, people in rural areas, and older adults. " (NDIA, 2022) According to Pew research center (Horrigan, 2016) digital readiness is defined as:

1. Digital Skills: The skills necessary to initiate an online session, browse the internet, and share content online.

2. Trust: A person's belief about their capacity to determine the trustworthiness of information online and safeguard personal information.

3. Use: The degree to which a person uses digital tools in the course of carrying out online tasks.

Families with little exposure to the internet, and families with no post secondary education are more likely to distrust technology and internet content (Horrigan, Sept. 2016). If there is little to no adoption of technology at home digital readiness will continue to slow for that family. Providing an opportunity outside the home is a key component in building digital readiness for young people.

Improve Digital Literacy

The second approach is to improve digital literacy among participants. The American Library Association definition for digital literacy is : *the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills*. It is clear from both the digital literacy definition and the concept of digital readiness that an internet connection is critical to overcome barriers in the digital divide. A key aspect of this proposal's solution is the micro:bit device which does not require an internet connection to operate. All projects and explorations can be done locally with just a computer. Even the device itself is battery powered freeing it from the classroom.

Every student in the community should have access to technology that is needed to contribute to the economy, to science, and to society.   Technology is the engine that is propelling students forward to achieve their individual aspirations. It is extremely important that there is a digital equity among students in the community; and that all students have the same opportunity to experience technology. Divisions in digital literacy, proper internet connections, and the basic hardware among students cause students to accelerate forward at vastly different rates (**add a source**).

It has been shown previously there is a need to leverage available digital tools in the marketplace to bring the latest concepts and technological innovations to the youngest members of our communities. The scope of this project is to improve digital literacy among the youngest members of our community. This means teaching children the most basic operating principles of simple computers, teaching the most basic forms of computer programming, and discovering the operating principles of the most fundamental sensors that enable technology to interact with the world. Children will learn to see things like phones, tablets, and computers as tools for learning and exploration as well as for entertainment. The 2015 Oregon " Nations Report Card (needs reference doc attached) shows from 2009 to 2015 achievement in science as a whole has been roughly flat despite Oregon receiving $156.5M in federal Title 1 dollars and$18.9M specifically for science for the 2018 fiscal year (US Department of Education, Sept. 2020)

Alternate Candidates

This proposal makes clear that the marketplace is rich with available hardware that could fulfill the needs of the program. There are three standout products with similar use cases and feature sets. The Raspberry Pi Pico, the Arduino, and the Micro:bit. It is the ultimate conclusion of this proposal that the Micro:bit fulfills the goal of bringing relevant concepts in technology to the youngest members of the community. The others will be briefly mentioned here.

The raspberry Pi Pico is a device from the Raspberry Pi Foundation (needs attached Figure). It is a small microcomputer at just $5. It is meant to be placed on a breadboard and additional components like LED’s, resistors, and speakers are connected to the breadboard. This approach greatly reduces the cost of the hardware however it is not really a simple all in one solution. Its geared towards beginners and experts, and as such has many features that 4th and 5th grade students will not be prepared for using. The second proposed device is an Arduino microcomputer. It is similar in cost and design to the Raspberry Pi. It also requires a breadboard and additional components to be affixed to the breadboard for exploration. Its target audience is middle school students ages 11-14. Future expansions of this project could include devices more appropriate for older children and the program can be set up to reach a wider audience.

Micro:bit an Overview

The micro:bit is a small form factor electronic PCB with a number of features which are all built into a stand alone device. An overview of the features is described below.

1. Buttons: The micro:bit has two buttons on the front that can be used separately or together to make things happen.

2. 25 LEDs arranged in a 5x5 grid make up the display for showing pictures, words and numbers. They can also act as sensors, measuring how much light is falling on the micro:bit.

3. Pins: The general purpose input and output pins allow a user to connect headphones, sense touch and add other electronics to expand the possibilities of your micro:bit. The new micro:bit has indentations to grip crocodile clips more securely. The user can power external LEDs and other electronics using the 3 volt power pin. The GND pin is the ground or Earth pin - it's used to complete electrical circuits when you connect headphones, LEDs or external switches to the user's micro:bit.

4. Touch logo: The new micro:bit has an extra input. The gold logo also works as a touch sensor. The user can use it as an extra button in programs, in addition to the A and B buttons.

5. Microphone: The user can create programs that react to loud and quiet sounds and measure noise levels with the new micro:bit's built-in microphone. The microphone LED shows the user when the microphone is actively measuring sound levels. Just to the left of the LED, a small hole is where the sound goes in.

6. Radio: The micro:bit can communicate with other micro:bits by radio, and with other devices using Bluetooth.

7. CPU and temperature sensor: The micro:bit's processor is its brain, fetching, decoding and carrying out your instructions. It also contains a

temperature sensor so the user can measure how warm or cold your environment is.

8. Compass: Find magnetic North or measure the strength of magnetic fields using the micro:bit's compass. It can measure magnetic fields in three dimensions for science experiments or for making simple door or window alarms.

9. Accelerometer: The micro:bit's accelerometer measures forces in 3 dimensions, including gravity, so projects can tell which way up the micro:bit is.

10. USB socket: Download programs to the micro:bit from a computer and power it using its USB interface.

11. speaker: The new micro:bit with sound has a built-in speaker so it is easier to add music and new sounds to projects.

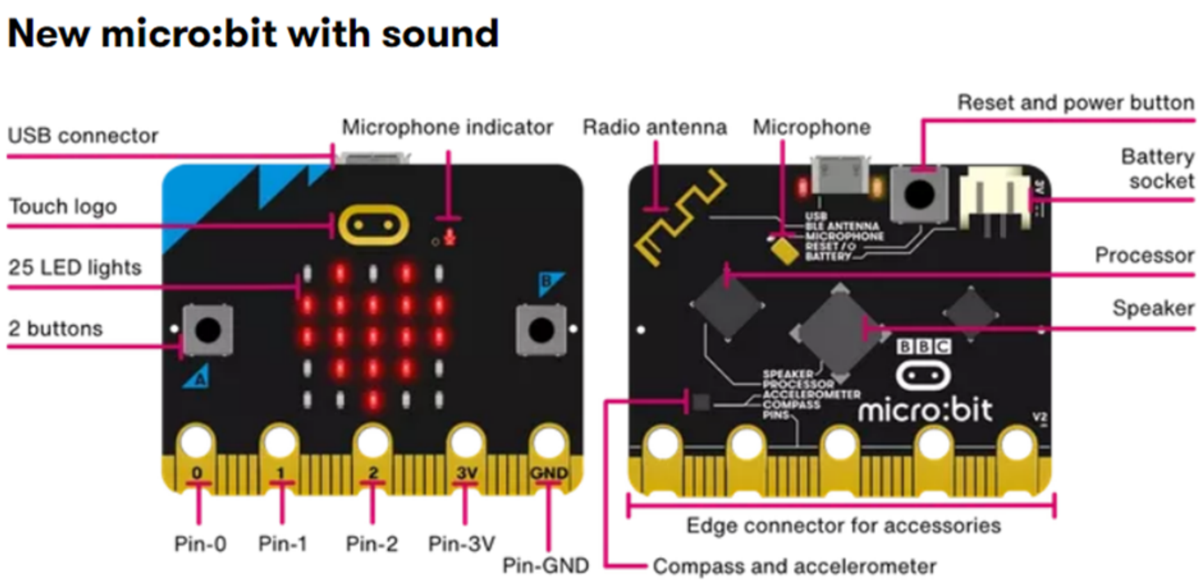

Figure x.

"The Micro:bit Educational Foundation is a not-for-profit organization. Our mission is to inspire every child to create their best digital future. By making the micro:bit the easiest and most effective learning tool for digital skills and creativity, we enable children to participate in the digital world, with particular focus on girls and those from disadvantaged groups. " (add citation)

Micro:bit Success

From early 2016, up to 1 million micro:bits were distributed to Year 7 students (or equivalent, aged 11-12), non-formal education settings and libraries across the UK in a project led by BBC Education. The response was overwhelmingly positive and the impact continues to this day. While the subject landscape for curriculum is varied, the micro:bit is being used as a tool for learning in all of these contexts. (add citation) An estimated 20 million children are learning with the micro:bit worldwide . There are 4 .5 million devices in circulation. There are micro:bit device in over 60 countries around the world

Program resources are held at the Micro:bit educational foundations website.

- Let's code: free online and offline software editors to help children learn how to code

- micro:bit classroom: the teacher tool to easily manage and review students' code across lessons

- Get started: guides, videos and projects to help you get going and explore the micro:bit in depth

- Projects: quick coding activities and longer problem-solving projects based on the UN Global Goals for Sustainable Development

- Lesson resources: complete curriculum-linked units of work with easy-to-download editable resources

Costs and Other Considerations

Upfront Costs

Table 1: Contains upfront costs for the Micro:bit

Item	Qty	Price(ea)	Total
Micro:bit Kit (Contains 10)	**3**	**$226.00**	**$678.00**
Accessory Kits	**30**	**$50.00**	**$1500.00**
Computers	**Already Issued to Each Student**		
Staff Chromebook	**5**	**$250.00**	**$1250.00**

Project Materials: Conductive Material, Construction Material, Crocodile Clips, Food			**$750.00**
Total			**$4,178.00**

Maintenance

Table 2: Contains Micro:bit yearly maintenance costs.

Yearly Maintenance Costs			
Micro:bit	**10% loss** **(3 Units)**	**25**	**$75.00**
Project Materials			**$500.00**

As you can see, the majority of costs associated with funding this program are up front. Providing accessory kits for the Micro:bit would allow students to fully utilize the capabilities of it. Staff would be able to tailor the accessory kit that they buy to what they plan to teach the students. Available accessories include but are not limited to:

- Environment kits to test the environment of the Micro:bit
- CO2 sensors
- Waterproof temperature sensors

- Gaming accessories so students can design their own games
- Internet of Things for small scale home automation
- Robotics

Purchasing Chromebooks for the staff would allow them to prepare their lessons ahead of time, share and view their students' code in real time, download their work for review, and capture the lesson to review it at a later date (microbit, 2022).

Along with the Micro:bits and computers, some basic project materials are needed as well. The Micro:bit board is designed to be able to attach crocodile clips to create electrical circuits with other components. Construction material can be used to build ramps for students to send their Micro:bits down if they are doing a project that involves measuring speed and velocity. Conductive material can be used with the Micro:bit to test conductivity. Finally, having snacks available for our students will allow any of them who are food insecure to be able to focus on the activities at hand.

Micro:bits are very durable for their price. A study conducted by the BBC found that for every 21 Micro:bits sent to teachers, 19 of them remained functional a year later (Discovery, 2022). This is where we arrived at our yearly 10% estimated loss. $75.00 a year will be able to replace any Micro:bits that no longer function and an additional $500.00 a year should be able to replace any project materials, and purchase more snacks.

With an initial cost of $4,178.00 and yearly maintenance of $575.00, a grant of $10,000 would fund this program for the next 10 years. An entire generation of students in an underserved area could get early exposure to STEM and find their passion earlier rather than later.

Other Considerations

- Time
- Space
- Staff
- Training

We recommend that students meet 1-2 hours a week for the duration of the school year. Research has shown that students perform better when their STEM learning is about 40 hours spread out over a period of time rather than more intensive shorter periods (Nugent et al., 2010). 40 hours was enough time to give students higher self-efficacy when performing robotics, mathematics, engineering, and programming tasks.

We recommend that staff use a volunteer science teacher's classroom or the school's cafeteria or library to hold these meetings. This would give the students ample room to do their projects, and would help keep the cost low since those spaces are free to use.

This program will need one volunteer staff member for every eight students enrolled. With 30 Micro:bit kits available, 3-4 volunteers will be needed. Ideally these volunteers would be science teachers from the school or teachers with an interest in science. If no teachers are available for volunteering then volunteers from the community would need to be vetted by the school.

Some instructors are worried that they need extensive training before they would be comfortable teaching students how to use a Micro:bit. Thankfully, Micro:bit provides short training tutorials for instructors on how to set up and use the Micro:bit. They also provide lesson plans and a detailed curriculum that the instructor can base their plans off of. In the BBC study referenced earlier, they took note of how teachers described the Micro:bit after use and the overarching sentiment of users were that the Micro:bit is easy to use, engaging, accessible, and the web resources are helpful in providing fun and relevant lessons and projects.

Back Matter

Citations

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