Hitchhiker's Guide to Computer Science for Social Good

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Abstract

Many college students want to make an impact at their schools, local communities, and the world at large. Many students who want to make an impact are limited by the lack of support, resources, and opportunities. About a year ago, we started planning and organizing a number of programs and events with the goal of building a close-knit community of responsible learners interested in technology and solving problems facing society, especially in education. In the spirit of passing on the baton and encouraging other college students to accomplish the same and more, this paper discusses challenges faced and lessons learned while implementing an enrichment program developed, in partnership with Google IgniteCS, for local Middle School students to learn about computer science – an opportunity that is not readily available to these students. We also briefly share about other events and programs we organized to develop a strong technical community on campus as well as strategies on how to replicate and improve such programs elsewhere.

Keywords: Computer Science Education, Learning Communities, Peer Mentoring, Google IgniteCS

1 Introduction

The ACM Special Interest Group on Computers and Society refers to "Computer Science for Social Good" as an umbrella term that incorporates any educational activity, from small to large, that endeavors to convey and reinforce computing's social relevance and potential for positive societal impact [1]. Computer Science sharpens skills that drive innovation in Science, Technology, Engineering, the Arts, and Mathematics. Since 2017, we have been planning and organizing various events and activities on The College of St. Scholastica campus and at the Lincoln Park Middle School in Duluth, MN.

Determined to find ways we could enrich our academic experience while making a positive impact in our college community, we decided to share the skills learned and knowledge gained in our classes and at internships with both our peers and younger students who had little to no experience or knowledge of Computer Science. We wanted to provide a platform for our college peers to learn from and teach others in their community. We desired to inspire young people to pursue careers in the Computer Science field. Originally, this idea had been pitched to the Phillips Scholars Program [2] and later on revised to fit the needs of students at Lincoln Park Middle School in Duluth, MN.

In order to develop and foster a stronger community at our college for all students interested in technology, we planned events such as tutorials and workshops where students could get together and learn from peers about various technologies and Computer Science skills. We developed a program with recurring sessions covering several different aspects of Computer Science in order to engage with and mentor younger students at the Lincoln Park Middle School. These sessions were used to teach key Computer Science concepts such as algorithms and computational thinking.

Pursuing both interests at the Middle School and at our college campus proved to be a herculean task as often we were limited by a lack of support and interest in such programs, inadequate financial and human resources, among other challenges. Despite the later, we were invested in the idea and wanted to accomplish our overall goal of making an impact by providing a shared experience for students to learn more about Computer Science through new skills that could be transferred and applied to their interests and passions.

This paper discusses two programs initiated by students as well as lessons learned through the implementation of the program and strategies on how to replicate and improve the program(s) to students looking to make an impact in their communities.

2 The Google IgniteCS Program

The Google IgniteCS program [3] is an initiative by Google that connects Computer Science undergraduates with opportunities to engage with and mentor younger students.

Goals of the IgniteCS Program

- to encourage undergraduate students who have an interest in Computer Science, diversity, and helping others to apply what they're learning in the classroom through mentoring.
- to provide a space or those undergraduate students who may be feeling discouraged on their own journeys to experience community, build confidence and create a mentoring program they can feel positive about.

Because the right mix of mentors, resources, and motivation rarely occurs organically in some communities, it is important to provide younger students a platform to learn about and experience the applications of Computer Science. Educating them at such a young age and equipping them with computing skills can enable them to accomplish more as they continue their education.

2.1 Program Development and Implementation

Following the application requirements of the Google IgniteCS program, we teamed up and looked for other students who were interested in volunteering and assisting with the implementation of the program. We started off with eight student volunteers studying Computer Information Systems, Finance, Accounting, Mathematics, Biochemistry, and Health Information Management at The College of St. Scholastica. We also approached faculty members in the Math Department and Computer Information Systems Department while seeking information and advice on who to contact to effectively design the workshops. As a team, we had the option to select a curriculum provided by Google or to make our own. We decided to do both and selected the "*Computational Thinking with 4th-8th Graders*" curriculum.

Computational Thinking for Middle School students

Google for Education defines computational thinking (CT) as "a problem solving process that includes a number of characteristics, such as logically ordering and analyzing data and creating solutions using a series of ordered steps (or algorithms), and dispositions, such as the ability to confidently deal with complexity and open-ended problems" [4]. Computational thinking is not only essential to the development of computer applications, but it can also be used to support problem-solving across all disciplines. Students learned concepts such as abstraction, algorithm

design, decomposition, pattern recognition, recursion, and iteration through hands-on activities and often without needing to use computers.

Program Duration

We started the program on February 7, 2018 and held our last session on March 28, 2018. Besides the occasions where either The College of St. Scholastica or Lincoln Park Middle School had spring break or when there was inclement weather, we met every Wednesday afternoon during the after-school activities time period.

Curriculum Outline

Our track comprised of six 45-minute lesson plans that included the following:

- **Session 1: Intro to CT and Algorithmic Thinking**
  - Learners were introduced to the program and to the first lesson on algorithmic and computational thinking. In addition to discussing everyday applications of computing, students also learned about abstraction and problem decomposition concepts.
  - Activity: Exact Instructions Challenge! Learners designed algorithms in teams of three to have the instructor successfully brush their teeth. They would write steps and the instructor would follow them as closely as possible, making it a fun activity where steps were not entirely clear or ommissive.

- **Session 2: CT and Algorithmic Thinking II**
  - We continued with leftover material from Session 1. We also had question and answer session where we talked about our academic careers and answered questions from students. Questions asked ranged from specific technology questions (mostly in video games) to general college experience questions.
  - Activity: The students enjoyed the Exact Instructions Challenge so we designed another challenge where they were tasked to write steps on how to make a peanut butter and jelly sandwich.

- **Session 3: Data Representation: Binary Digits**
  - Learners were introduced to data representation and data storage. We started off by introducing counting techniques in base 10 and observed learners were able to easily translate that to counting in base 2.
  - Activity: Learners played games with cards with dots and counted in binary.

- **Session 4: Ciphers and Human Computer Interaction**
  - Learners ciphered a sentence, and learned about strong passwords, and cybersecurity basics.

    - Learners explored the concept of usability and then designed an app interface on paper.

- **Session 5: Algorithms: Divide and Conquer (Binary Search)**
    - Learners played interactive games encouraging algorithmic thinking. They also did some hands-on activities to learn about Divide and Conquer (binary search algorithm).

- **Session 6: Closing - IgniteCS Friends & Family Day**
    - Learners, their friends, teachers, and volunteers celebrated the end of the program during the IgniteCS Friends & Family Day.
    - Volunteers shared closing tips and general advice to learners and their families on what they could to continue developing their passion and skills.

Figure 1. The authors and students during one of the sessions in our IgniteCS program at Lincoln Park Middle School (LPMS).

Resources and Materials

Through the Google IgniteCS program, we were provided with all the resources we needed to implement the program. This included a curriculum on our topic of interest (Computational Thinking) and full lesson plans for each session. Two of the authors attended the 2017 ACM Richard Tapia Celebration of Diversity in Computing conference. They met with representatives from Google for Education and received free copies of *Careers with Code* magazines [5] that were later on shared with participants, volunteers, and the college's Career Services center.

We were also able to get more resources and share notes with other college students from the United States and Canada through a Slack channel that was created for all Google IgniteCS volunteers. Besides free t-shirts and water bottles, one of the perks provided was an opportunity to sign up for mentoring with various professionals working in STEM fields. These included technology professionals working in academia and industry as well as other students.

Transportation
We only needed to plan for transportation to and from the host institution, Lincoln Park Middle School. We mostly relied on our college's vans, but on other occasions, our faculty advisor and/or community partner would provide transportation as needed.

2.2 Challenges faced

Bringing together a group of students who were committed to creating a Google IgniteCS in Duluth seemed to have been a smooth process. It was not until we were to start scheduling group meetings that we faced our first roadblock. Taking into account that we were all college students, our school and work commitments seemed to be getting in the way of some of our team members. After having been able to overcome this and set dates and times that would work for most of us, we came to the crucial decision of choosing the school we were to implement this Computer Science club. We first contemplated the idea of teaching High School students, but were unsure if aiming for a younger audience would present students with an earlier exposure to the technical skill we desired to teach. Having sought faculty's advice we came to the mutual decision to implement our Google IgniteCS program at Lincoln Park Middle School. Taking into account the lack of support, both morally and financially we considered this to be our most reliable option. Professors at The College of St. Scholastica had already taken part of Computer Science related activities with this Middle School and had created a relationship with the school's officials.

Embracing the support that we were given by those professors who were familiar with this institution, we then came upon the challenge of commuting to the middle school. Two of the students who were to teach the lessons did not possess a car nor a local driver license that would allow for them to use the college's vehicles. Public transportation failed to be an option, for the time in which the bus runs to that area interfered with our classes' schedule. This issue was brought to two of our professors' attention; they kindly offered to drop us off. We were able to get another team member to pick us up at the end of each session.

From the moment in which we started our first session, we noticed the underrepresentation of girls in the workshops! We noted how there were few girls attending and participating in the workshops. Despite the fact that these girls presented themselves as eagerly wanting to learn

more about this area, their absences became more noticeable as the workshops kept on taking place. Attendance itself was an issue, despite the fact that the Computer Science teacher promoted the club, students were either interested in other sports-related after school activities or would forget the workshops were taking place.

2.3 Recommendations

While there is no formula for successfully implementing such an initiative, we have compiled some recommendations below, largely based on our experiences and recommendations from other groups such as The Women's Foundation of Colorado [6]:

Recommendations for students

- Identify the community's needs and determine what can be done, how to do it, who to contact or seek advice from, when to do it, etc.
- Develop a plan and be adaptable as you go along.
- Connect with organizations that support similar work such as Google IgniteCS, CODE2040, GitHub Education, JPMorgan Chase Technology for Social Good, Microsoft TEALS program, etc.
- Start early and find others who are as motivated and have same interests or have experience in what you are planning to do.
- Utilize whatever resources your institution may have. Some colleges provide transportation to events, free web hosting and advertising of your program, etc.
- Find a mentor or advisor to help you navigate, organize, network, and carry out any tasks needed to successfully complete your project.
- Have personal goals and an idea of what you will learn from the experience. Share with others, i.e., pay it forward. Seek opportunities for personal growth and development and always find ways to share with others whatever lessons and knowledge you acquire in the process.
- Create lesson plans that can be adapted to the students' areas of interests.
- Incentivize students who attend the workshops with either prizes or snacks.

Recommendations for colleges, universities, & academic institutions

- Provide support and aid for students, postdocs and faculty to participate in outreach activities, perhaps even sponsoring TA positions for interested students.
- Encourage students to contribute to their local communities through volunteering efforts.
- Start or support local academic and mentoring programs for minority students that bridge the transition from high school to college.

- Form partnerships with minority serving institutions —both academic and community based— to identify the best ways to interact with these communities
- Commit resources (money, interested staff, time, books, etc.) to support engagement in local underserved communities, to encourage citizen interest and understanding of the field of Computer Science.

Recommendations for organizations, companies, and professional societies

- Provide opportunities for continuity of funding for education programs.
- Continue to fund and expand Computer Science education programs that focus both on student enrichment and teacher professional development in underserved communities.
- Fund efforts to expand informal learning in underserved communities.
- Identify exceptionally effective K-12 outreach and education programs and see that they are widely adopted, particularly in underserved communities.

Recommendations for parents/caregivers

- Expose kids to opportunities for exploration and support them throughout by learning with them and attending events with them such as the Family Hour of Code.
- Foster curiosity early on and encourage asking questions.
- Advocate for your local school(s), library, or other community learning center to sign up and partner with education initiatives such as the Google IgniteCS program.

2.4 Successes and lessons learned

Some of the best moments we had included:

- Times when the 8th grade Computer Science teacher attended our sessions to not only help us manage the kids but to also find ways to better develop his curriculum and incorporate some of our lessons and activities.
- Having the students ask questions and contribute to our various discussions. They also showed a strong interest in learning and enjoyed working in teams especially during activities such as the Exact Instruction Challenge.
- We also wanted this to be an opportunity for us to learn. Through this program, we learned and enhanced our project management skills, acquired teaching and mentoring skills as well as honed our communication and planning skills. We also built a website for the project and handled social media accounts for posting updates about our work.

3 Establishing Learning Community on campus

Inspired by the tenet that "*Students learn a great deal by explaining their ideas to others and by participating in activities in which they can learn from their peers*" (Boud, 2001), we have organized events and workshops for students by students where all levels of experience are welcome to commune and learn with others. [7] Our goal was to provide a platform for collaboration and to support students in their learning endeavors and excitement over how Computer Science applies to different subjects.

Through Learning Communities, students are able to practice and learn valuable skills that can be applied to future careers. Since Fall 2017, we have organized beginner-friendly and peer-led workshops where we shared resources and knowledge in small groups about how to prepare for technical interviews and apply for internships. Students were able to learn about subjects that were often not taught in our classes such as building personal portfolios, tackling technical interviews, etc.

Outside our own efforts to foster a strong tech community on campus, there are a variety of programs we have utilized and are currently making use of:

1. **CodePath.Org iOS Development Course**

CodePath offers free in-person coding classes that supplement regular college Computer Science courses and prepares participants for work in the technology industry [8]. Universities can partner with CodePath to bring such courses to their campuses with the option for students to gain credit if necessary or to participate as part of a cohort. The on-campus courses run for 12 weeks and are led by peers, i.e., students who sign up as Teaching Assistants and are trained by the CodePath staff to facilitate the course.

In Fall 2017, we partnered with CodePath but unfortunately had to cancel as were unable to get enough students to sign up for the Spring 2018 iOS course. At the time, CodePath required a minimum of 20 students to sign up for a course and at least 2 Teaching Assistants to support the cohort.

2. **MLH Localhost Program**

Students looking to build a strong community on campus and to learn and to teach valuable technology skills to their fellow peers can participate in the Major League Hacking Localhost program [9]. Through this program, any student can register as an MLH Localhost organizer, select a workshop, get trained and oriented, receive promotional support and resources, and host an event at their school or local space. We recently hosted a workshop this semester to teach students how to build and deploy a portfolio website. This was our first time being part of the MLH Localhost program and we plan on hosting another event next semester (Fall 2018).

3. **GitHub Campus Expert Program**

With the GitHub Campus Expert Program, students undergo training and learn public speaking, technical writing, community leadership, and software development skills that will help them coordinate programs and activities to improve their campus communities [10]. The training takes place online and is self-paced. In addition to training, Campus Experts have access to resources and support from GitHub, such as swag, sponsorship, and the opportunity to attend events like the GitHub Universe. One of our authors is currently participating in the 2018 Campus Expert Training.

Getting started with establishing a Learning Community (LC)

Our experience so far has taught us that finding other individuals with the same motive and interests is perhaps one of the best ways to get started in making an impact in your community. This, and connecting with faculty, staff, professionals, and other individuals who might invest in your idea(s), forms a strong foundation to build the learning community on.

We were fortunate to have faculty and staff members who supported the idea of building and fostering a strong technology community on campus. When we approached those members, they would share our program and event information with colleagues and other students.

Challenges and Recommendations

We faced some challenges during our program and have come up with recommendations to overcome these challenges:

1. Scope and/or advanced material - There a lot of resources that can be used during workshops and a good number of those can be beyond what is generally taught in class. This was an issue we had while partnering with external organizations and realized that some students were not as open to the idea of learning new technologies while taking a full course load. A recommendation for such cases would be to know your audience first and well enough, and then build on their experiences with new material. This could be beneficial in that all get to learn new things and expand on what they already know.
2. Low attendances - Few students at our College of St. Scholastica campus study Computer Information Systems and even fewer of those could make it to the workshops. One way to overcome this is to plan well in advance for all sessions and advertise rigorously. Having free food and swag available (stickers, water bottles, t-shirts, etc.) can also help improve the tally. Another recommendation is to encourage students to bring a friend, especially to beginner-friendly workshops.

4 Conclusion

This paper discussed a student-led initiative that seeks to empower and provide college students with an opportunity to apply their skills to inspire younger students to pursue Computer Science. Engaging students during the early stages of their academic careers in creative and informal settings can go a long way in retaining their interest in Computer Science. We also discussed initiatives by students that seek to foster a stronger sense of community on campus. Students learn better when they can learn with a community of like-minded peers. We highlighted some of the challenges we faced while implementing different programs and recommendations on how to effectively develop similar programs to get more students involved in Computer Science, especially early on, and strategies to develop and foster strong technical communities.

Supporting college students can help create possibilities for them to learn and work with others, and create potential to connect interest learning to future opportunities.

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