

UNDERREPRESENTED STUDENTS IN COMPUTER SCIENCE: UNDERSTANDING THE BARRIERS OF ENROLLMENT AND ENGAGEMENT IN COMPUTER SCIENCE COURSES IN HIGH SCHOOLS

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Introduction

- This project is funded by the National Science Foundation CS for All: Research and RPPs program, Award No. 2122367
- Overview of Project
- Year 1—Qualitative Interviews with High School Students

Research Gaps: Why Study Underrepresentation in CS?

- Labor Market Demand for individuals with computing degrees
- Lack of diversity in CS
 - *Lack of interest in CS among HS students*
 - *Lack of persistence in CS (retention)*

Research Gaps

- Students from underrepresented groups in CS not asked about their interests/experiences
- Underrepresented students in CS
 - *Females*
 - *Low SES background*
 - *Racial Ethnic Minorities*
 - Black/African American; Hispanic/Latinx/Chicanx; Native American/Alaskan, and Native Hawaiian/Pacific Islander, or multi-racial (DataUSA, 2020)

Bringing in Students' Voices

- Cogenerative Dialogues (Cogens)—Christopher Emdin (2016)
- Cogens utilized to develop a *Culturally Relevant Pedagogical Framework for Computer Science and Computational Thinking*
 - *To promote interest and engagement with CS and CT across the high school curriculum*
- Students involved as **participants in interviews** to find out barriers/challenges they experience (Year 1 of NSF grant—findings discussed in this presentation)
- Students included in **17-member framework development team** (Year 2 of NSF grant—currently underway)

Relevant Research Question

- What are key fundamental challenges faced by underrepresented students (female students, low SES students, students of color) in enrolling in and/or engaging with computer science courses in secondary schools?

Methods

- Qualitative Approach

- *Semi-structured one-on-one interviews with students*
- *Recruitment*
 - Purposeful Sampling
 - 3 Research Sites: one urban, one rural, and one suburban high school
- *Interview Screening Survey*
 - Each school to submit names and contact information for 40 students who meet criterion of underrepresented group in CS (1/2 of students will have taken CS course; other 1/2 will not have taken a CS course as of yet)

Sample

- **Target sample size:** Total of 50 students from across 3 high schools
- **Low response rate**
 - *Urban school data not yet collected*
 - *Unequal number of students who have taken CS course vs. not yet taken CS course*
- **N=26**

Sample (Cont'd)

- Identify as female: 18 (69%)
- Identify as male: 5 (19%)
- Identify as non-binary: 3 (11.5%)
- Identify as a racial minority in CS: 10 (38%)
- Do not identify as a racial minority in CS: 16 (62%)
- Low SES: 8 (31%)
- Not from a low SES: 18 (69%)
- Completed OR are currently enrolled in a CS course: 15 (58%)
- Have not completed a CS course: 11 (42%)

Interviews

- 26 in-person semi-structured interviews
- Duration of time: 20-30 minutes (25 minutes, average)
- Interview Protocol Guide Questions

Interview Protocol Guide Questions

- Connection to technology
- Favorite classes in high school
- Have you taken a CS class in high school (Yes/No)→different questions
- YES:
 - *What CS classes have you taken? Discuss*
 - *Did you enjoy the CS class(es)?*
 - *Discuss students and teachers in CS class(es)*
 - *Sense of belonging*
 - *Participation*
 - *Students treated differently*
 - *Challenges in your CS class(es)*
 - *Computer or technology-related clubs*
 - *Computing experience outside of classes*
 - *Plans after high school?*
 - *Talk with family about CS classes?*

Interview Protocol Guide Questions

■ NO:

- *Participation in classes*
- *Sense of belonging*
- *Students treated differently*
- *Challenges with classes*
- *Consideration of CS classes in the future*
- *Computer or technology-related clubs*
- *Computing experience outside of classes*
- *Computational thinking skills and classes*
- *Plans after high school*
- *Talk with family about classes*
- *Knowledge of CS field*

Data Analysis

- Grounded Theory Approach
- Use of Memos (theoretical, case study, and conceptual)
- MAXQDA
- Open Thematic Coding
- Code frequencies
- Themes
- Patterns

RESULTS—Common Themes

- Challenges
 - *Financial Factors*
 - *Role of Gender (Identifying as Female)*
 - *Race/Ethnicity*
- Positive Influences
 - *Role of Teacher*
 - *Role of Family*
- Other Interesting Insights
 - *Wanting to be challenged in CS courses*
 - *Marketing of CS as a discipline*

Financial Factors

- *I'm sure next year is gonna be mostly guys for my computer science classes, and that's- I feel like that's how it is in a lot of like camps and things like that. Like I don't ever take computer science camps 'cause it's like 'Eugh, I'm gonna be the only girl. It's gonna be awkward.' That sort of thing.*

[So you wouldn't do any camps because of that reason?]

*Pretty much, **and also money, but.** . . (I, CS-Yes)*

- *If I want to work on something at home, it's a little more difficult because, you know, the equipment is here at school, and I was thinking of maybe getting not a school issued computer to be able to download more like, applications, like there's real basic where it has python, C++, and all that in there, but I am not able to do that with a school issued computer.*

[So, do you have plans to get your own computer?]

Yeah, I mean I was trying, but it's a lot of money. (A, CS-Yes)

Gender/Female

- *I'm the only girl in my CSA class. . . it doesn't really bother me all that much, but and I only knew a few kids in the class, but um I don't think there was anything really about the demographics that really um negatively impacted me. . . sometimes somebody might say something like, "Oh, you know how, what is it, what's it like to be like the only girl in the class?". . . it doesn't feel great to always be called out, like, I just want to be seen as a computer science student or an engineer I don't want to be seen as a **female** computer science student or a **female** engineer. (Q,CS-Yes)*

*[Do you feel intimidated at all by the fact that you are one of the few girls there?
Despite the fact that you have a female teacher?]*

- *I do. I think it's both. I am basically ahead in that class, and I know some kids that aren't, and it makes me feel better, because I thought that if I was a girl, I couldn't do it, but here I am. . . I try to encourage others to do it because of the aspect of being the only girl with a lot of guys everywhere, and it's tiring, and also people of color, and I don't know, I just want more involvement for everybody. (A, CS-Yes)*

Race/Ethnicity

- *It's [challenges at school] definitely harder than it looks. Like I'm not even like visibly um someone of color, but I still got a lot of comments, just like little things like, "Are you adopted?" Or "Oh, what country are you really from?" And I was like okay, just like it's the student influence. I think if teachers would have stepped in and said, "hey you know, that's not okay." I mean, the only person who's ever done that for me was my teacher in 7th grade, and I'll always remember him. He literally told off these people for talking to me like that, and it was really really great, but other than that teachers just kind of turn a blind eye. I think it's not their fault; they don't really know what to do, but I feel like that should be something that should be changed. (S, CS-No)*
- *I mean, I'm not going to lie, this school is mostly White. Since I've been here, there's maybe a handful of people of color here, but there's not really a lot. It's gotten better, but it's just. . . I remember in English class we were talking about controversial topics, and this one girl brought up how people would comment on her because she looks different, and I was like, I can relate because you know, you're just different, the handful of people here. (A, CS-Yes)*
- *I would never say I feel disincluded. Obviously the whole thing about it not being diverse, but, um, you know, just being a person of color in an area like this, you get used to it. I'm not closed off to anybody based off how they look so, that's just how it goes. I have many great friends that I have made in my computer science courses. (Y, CS-Yes)*

Race/Ethnicity (Cont'd)

- *I think a lot of people who are underrepresented--you know, some fault lies in how society is and the certain pressures and stereotypes that people put on certain endeavors but especially with the people in my school, the opportunity is sitting right there. So, if I can do it, then anyone can do it. [This] is really what I'm trying to say because when you're presented with opportunities but you don't have the willpower to take them then all you can blame is yourself so I really would say when it comes to groups like myself being underrepresented in STEM, especially in areas like this where it is available, you just have to open your mind and get out there and learn things. . . Go out and learn and if it's not for you, then it's not for you but you're never gonna know unless you try. (Y, CS-Yes)*

Teacher Influence

- *[Teacher] was awesome. [They] definitely explained things in a very coherent way. You can understand it even if you knew nothing about computers before that, so it was definitely a really nice introduction and it definitely kept me interested and from there on out I've had [teacher] . . . the way that they teach, it's really, it's engaging and they make sure that you understand the concepts. The content in computer science classes, it builds off what you learned before you know. So, if you're not understanding stuff at the beginning of the year then you shouldn't expect to understand a lot of things at the end of the year. Yeah, really taking us step by step and making sure that we have a good solid foundation so we could carry it out into the bigger subjects and the harder subjects as the year goes on. (Y, CS-Yes)*
- *[Teacher], [they are] really nice, and [they] really help. Like if you don't understand something, [they will] really like sit with you and help you work through it. (D, CS-Yes)*
- *Uh Yeah, [they are] really nice and [they] take [their] time. I really enjoy that aspect. [They do not] like rush us through anything. (F, CS-Yes)*

Teacher Influence (cont'd)

- *I really liked [teacher]; I think [teacher's] still my favorite teacher. They were really nice, and they were always there to help you out with your code. They explained it in a really nice way, in a way that you could fully understand it. (A, CS-Yes)*
- *Super helpful. . . [they are] just very calm and. . . I very much enjoy [them] as a teacher. Um, [they don't] give you the answer, which I like. [They] sort of lead you in the direction of the answer, um, because I hate it when they're just like 'oh well it's this!' when I just have like a simple question. (I, CS-Yes)*

Family Influence

- *Yeah, I've talked with my parents a lot, especially my dad. They said engineering -- that's like a good career to go into 'cause it's growing a lot, stuff like that--computer science. [So they're supportive of you going off to college and pursuing something with engineering or computer science?] Yeah. (C, CS-Yes)*
- *I mean they all support it. They think it's pretty cool, um, they know that it's well-paying so, that's another supporter, but yeah, you know, I just tell them about it. They're all onboard. (I, CS-Yes)*
- *Yeah, I do like computer science. Also as I said, it's a lot of guys and I just want to be like one of the girls in it to change it. Also my mom is really pushing me because none of my family members have really finished college. (A, CS-Yes)*
- *In freshman year when I was going through my course selections my mom pointed out that I should just. . . try Programming I because it's a field that's, you know, actively needing more people, so she recommended me that, and I accepted it and I got into it. (T, CS-Yes)*

Family Influence (Cont'd)

- *[So have you ever considered taking a computer science class? So you haven't taken one your senior year, you're about to graduate; have you ever thought about taking one? You talked about your father being a programmer, initially.]*
 - *I think I was always just kind of turned away from it because I grew up seeing, what like I perceived as his career and it was always just like, "No, that seems boring. I don't want to do that," but I know that like realistically moving forward, now that I'm like growing up, I realized that going into STEM field especially in like 2022 I'm going to need some kind of uh foundation at least in computer science, so I'm definitely not opposed to it or not as opposed to it as I was based off of the perceptions that I had in the field growing up. (V, CS-No)*

Family Influence (Cont'd)

- *We have conversations at dinner; I talk with friends on the phone about it; we talk about our classes. They're really supportive. They make sure I'm doing something practical. I want to do something practical, but also something I enjoy. I'd say they push me too, to take the harder stuff and I'm glad I do. . . I mean he—my dad [father has master's degree in Data Analytics] has brought it up a couple times, but he kinda got that wasn't my thing. I wasn't really interested in that so he kind of stopped pushing me in that aspect. (J, CS-No)*
- *I know my dad he was very supportive of my brother taking IT considering like the growth in technology and how well you can do when you have a computer-related job. Uh, so was my mom, she was very supportive of him, um they never- I guess they never really viewed me as one to be involved in computers since I never really showed an interest. (K, CS-No)*

Interesting Insights

- Wanting to be challenged more in CS courses
- Marketing of CS as a discipline

Wanting to be Challenged More in CS

- *I don't know if I can come up with many challenges, I mean maybe the, it's not necessarily related to me being like an underrepresented student, but yeah, sometimes, like, I wish there was more opportunities for us to explore possible career fields like cyber security, digital forensics, um game development. Not just, you know, learning how to code in a language, or you know, applying it to very basic things like calculating a grade. You know that's all great for learning how to do it.. . . More applications. . . I've found if I didn't have stuff to do in the class like I found like I just kind of would sometimes do like personal projects , you know? (Q, CS-Yes)*
- *I kinda just don't like doing the same thing over and over again. I like more like exploring options. . . I just kinda, don't say it. (F,CS-Yes)*

Marketing of CS as a Discipline

- *I think just one thing is that the school might need to make computer science a bit more intriguing, because I don't think enough people do programming classes in school, but they don't really have like a motive to try it. So I think they need to somehow make it more interesting to the common eye so they can start doing more, so people start joining programming class to at least try it. (T, CS-Yes)*
- *I think a big thing that would help connect with just like anybody even if it's not underrepresented people in the field is just like try to show that there are more inventive or creative ways to reach out with computer science. Like I'm sure that there are, I don't know what they are personally, but if they're out there, the way that those classes are taught or the outcomes--make them appeal more to people. Even though I'm going to STEM, like, I love the humanities and I'm really involved in those, if you could get more kids who generally steer towards English or like animation or stuff like that and show them the opportunities and give them like actual class time to do that. I also don't really know, like, how the programming classes are taught, 'cause I've never taken them, but some of my friends have and it just seems like, I don't know you just sort of sit there and write codes and like run your program and if it doesn't work, you have to figure out what went wrong and then just sort of like the same thing over and over again. I never really heard about them doing anything, what seems cool as like creative or with different applications (V, CS-No)*

Marketing of CS as a Discipline (Cont'd)

- *I would just say like making it clear that everyone has- like has the opportunity to have a place in that field. 'Cause again, I really feel like I fell into like the concept of, 'You're not a math kid.' Like therefore you're not good at it, therefore you don't pursue it. I don't think I would have either way but, like, specifically with my math experience this year, I was so under the impression that I just couldn't--that it wasn't for me and that's why I always took like the College Prep classes in math. Like I probably could have taken Honors math class and done just fine, but I was always under the impression that like once you're told that like math maybe just doesn't instantly come naturally to you that it's not something you pursue and I don't think that's what should determine if someone pursues a career or not. Like if they- everyone has the opportunity and so I think if it's marketed like "computer science is a class for everybody," 'cause I don't think-- like it seems to be like marketed to a very small group of students, like if this is your thing then you take a computer science class, if not you take the Microsoft word class and hope for the best. And so it's like, there are so many computer science classes that I know we offer and if it was marketed as like, "Hey, these classes are available to all of you guys. . . it's not like there's a requirement for certain courses on the entry level that you have to have taken in order to take these computer science classes." (N, CS-No)*
- *I think it would be good to find ways to really get more, more people and underrepresented groups interested, you know, as much as I don't mind being the only girl in my computer science class, it would be nice to, to really get more interested. I'm not sure why um there isn't as much of an interest, maybe there might just be a misunderstanding about what computer science is or what coding is, um and I think like there are ways we can--I think we can find some ways to expose more girls like at the middle school level. I know um the middle schools, they do a Girls In Stem night. I think it's most focused a lot around engineering, so like we can incorporate computer science into that, I think that would be really good. (Q, CS-Yes)*

Theoretical Framework: Social Identity Theory

- **Social Identity Theory:** aims to specify and predict the circumstances under which individuals think of themselves as individuals or as group members; also considers consequences of personal and social identities for individual perceptions and group behavior
- **Related research:**
 - Lopez, J., Garcia, A., Ross, M., & Uribe-Gosselin, C. (2022). *What is a Computer Scientist?: Unpacking the Ontological Beliefs of Black and Hispanic Female Computing Students.*
 - Cheryan, S., Master, A., & Meltzoff, A. N. (2015). *Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes. Frontiers in Psychology, 6, 1–8.*
 - Peters, Anne-Kathrin & Pears, Arnold. (2013). *Engagement in Computer Science and IT – What! A Matter of Identity?. Proceedings - 2013 Learning and Teaching in Computing and Engineering, LaTiCE 2013.*

Limitations/Directions for Future Research

- Preliminary Findings at this point in time
- Small sample size--generalizability
- More data on low SES needed
- More racial ethnic diversity needed
- More males needed
- Urban school data not yet collected

Conclusions

- Preliminary Findings
- Barriers to underrepresented students not always acknowledged by them...why?
- Positive influences just as important to study as barriers/challenges
- Gender/Female: minority of females in CS persevere in the field
- Race/ethnicity: noted by students but not seen as a “problem” by most
- Role of family—worthy of further research
- Quality of teacher/curriculum important
- Marketing of CS as a discipline—breaking stereotypes and marketing CS For All



ANY
QUESTIONS?