State of Computer Science Education in Michigan

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MICHIGAN Department of Education

Contents

OVERVIEW

The primary purpose of this report is to provide a description of the state of Computer Science (CS) education in Michigan, along with results from a survey of administrators and teachers around Computer Science courses and related offerings. This report also addresses challenges in access to CS, as well as recommendations for the future of CS education in the state of Michigan.

STATE OF CS IN MICHIGAN

- Michigan has 15,367 open computing jobs (3.8 times the average demand rate in Michigan) with an average salary of $82,386, which is significantly higher than the average salary ($49,510).
- Only 2,467 bachelor's degrees in Computer Science in Michigan in 2018
- Only 3,871 exams were taken in AP Computer Science by high school students in Michigan in 2019 (1,165 took AP CS A and 2,706 took AP CSP).
- Lack of diversity in high school AP computer science (29% female, only 150 Hispanic or Latino students, only 148 Black students, 10 American Indian or Alaska Native students, and 1 Native Hawaiian or Pacific Islander students.

Source: State Facts, Code.org

INTRODUCTION

According to statistics from Code.org, (67%) of all new STEM jobs are in computing while only (11%) of new STEM degrees awarded are in computer science in the United States. And computing jobs are projected to grow twice as fast as any other field between 2018-2028 and there are half a million current openings. Within Michigan, there are 15,367 open computing jobs (3.8 times the average demand rate in Michigan) with an average salary of $82,386, which is significantly higher than the average salary ($49,510). Despite this demand, Michigan had only had 2,467 computer science graduates in 2018 and only (19%) of them were females. At the same time, in 2019 only 3,871 high school students took the AP CS exam with 1,165 taking the AP CS A exam and 2,706 taking the AP CSP exam.

In addition, U.S. society is surrounded with the Internet, apps, social media, and a multitude of other technologies. In 2019, U.S, teens reported an average of 7 hours and 22 minutes of daily screen use outside of school or homework (Rideout & Robb, 2019). About (95%) of U.S. teens own a smartphone, and (45%) of them report being online "almost constantly" (Anderson & Jiang, 2018). Similarly, children aged 0-8 use phones and tablets (i.e., videos, games, apps) at an increasing rate (Rideout, 2017). But while computer science (CS) is responsible for most of the hardware and software we use, only (45%) of high schools in the U.S. teach computer science (Code.org, 2019b). Within Michigan, only (23%) of schools (153 schools) with AP programs offered AP computer science courses in 2017-18. That is, a considerable number of students, with a higher rate for girls and underrepresented minorities, are not formally trained in understanding, analyzing, and creating the tools and media they use daily. Because computing and information technology "has now reached the point where it can be considered a true utility, much like electricity" (Ford, 2015, p. 176), it is more important than ever to understand computing as a fluid competency that, much like literacy, evolves based on its technical, historical, or social context (Vee, 2017).

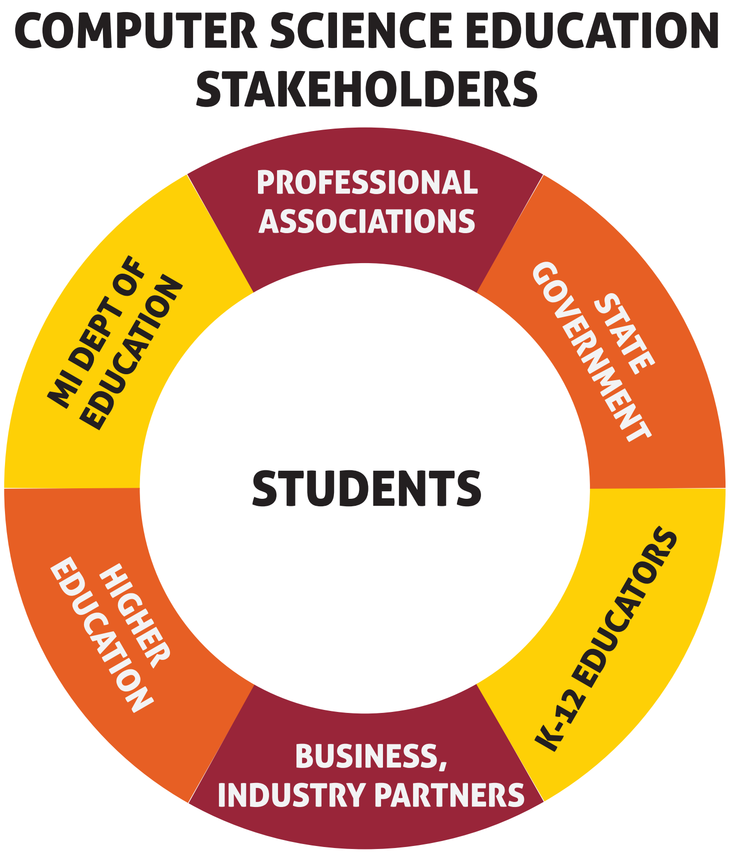
CS education in the 21st century has implications not only for economic and workforce development, but also for social justice, creativity, citizenship, and personal agency (Santo, Vogel, & Ching, 2019). In addition, equitable access to CS education for all students is key to respond to both the demand for qualified workers in computing-related jobs, and to develop the critical thinking and innovation skills needed to solve problems in an increasingly complex, digital, and global world (Google & Gallup, 2017).

Recently, there has been an increasing push to also integrate computer science in core subject areas and not just offered as a standalone subject. Vogel and colleagues (2019) suggested that K-12 computer science learning experiences provide students with opportunities to write code, collaborate, produce meaningful projects, deepen their conceptual understanding in a subject area, and also critically understand the impact of technology. They further argued that language plays a central role in these activities given that "the ways computer science is taught and learned with and through language" (p. 1164). As such, computer science has become a true literacy "for both reading (consuming or using computation) and writing (creating)" (Guzdial & Naimipour, 2019).

COMPUTER SCIENCE EDUCATION IN MICHIGAN: CURRENT EFFORTS

To match the increasingly higher demand for jobs in Computer Science (CS), information systems, and software or application development, a group of computer science education stakeholders, convened by the Michigan Department of Education, identified access to CS learning opportunities as critical to student success. Michigan views CS education as a path to "develop foundational computer science skills to solve problems and be constructive citizens" (MDE, 2019). As part of these learning objectives around CS, Michigan envisions that students will practice creative problem-solving through computational thinking, around topics of: algorithmic problem-solving, computing and data analysis, human-computer interaction, modeling and simulating real world problems, creating and manipulating graphics, programming (i.e., game design, web design, robotics), and ethical and social issues in computing (MDE, 2019).

The group recognized that computational thinking connected the Michigan Integrated Technology Competencies for Students (MITECS) to computer science, but did not encompass all of the concepts of computer science. The MITECS, which replaced the Michigan Educational Technology Standards for Students (METS-S) were released in December 2017 and adapted from the 2016 International Society for Technology in Education (ISTE) Standards for Students, are competencies that focus on learning enhanced by technology, rather than on technology tools. While the MITECS support learning with technology across the content areas, computer science is the study of technology and how to create technology. The MITECS and computer science have different roles but work together to better prepare Michigan students.



The group utilized the strategic goals (2, 3, 4, and 6) provided in MDE Top 10 in 10 Years - Goals and Strategies and the K-12 Computer Science Framework to guide the computer science standard process. The Michigan State Board of Education therefore adopted K-12 computer science standards in May 2019 to outline the foundational learning objectives in CS for MI students and guide curriculum design at the local level. However, barriers to CS education are still present at the district, teacher, and student level. In addition to adopting CS standards, the Michigan Department of Education hired a Computer Science Consultant to lead the CS efforts and initiatives, and allocated funds through MiSTEM (2018) for CS education opportunities in K-12.

In order to expand access to computer science at the state level, Expanding Computing Education Pathways (ECEP) groups has suggested a five step process: 1) Find your leader(s) and change agents, (2) Understand the CS Education Landscape to identify key issues and inform policy, 3) Gather and organize allies to establish goals and strategic plan, 4) Get initial funding to support change, and 5) Utilize data to provide evidence to inform strategic Broadening Participation in Computing (BPC) efforts. As such, the Michigan Department of Education, currently in step 2 and 3 of that process, has been leading a multi-pronged approach for computer science reform at the state level.

The present report is one of the ECEP steps and provides a description of the state of CS education in Michigan, along with results from a survey of administrators and teachers around computer science courses and related offerings. It also addresses gaps and barriers in access to CS, as well as recommendations for the future of CS education in the state of Michigan. The survey looked at current CS courses or activities available in the state, as well as administrators' and teachers' perceptions of these offerings. We asked:

- What are school leaders' perceptions of K-12 computer science and its importance in K-12 schools?
- What computer science opportunities do K-12 school leaders believe exist in their schools and what barriers exist for offering CS?

SURVEY ANALYSIS

In order to examine perceptions of computer science among school administrators and leadership as well as what computer science opportunities they believe exist in their schools, we invited district and school leaders (superintendents, principals, and curriculum directors) from Michigan to complete a survey. We drew our survey items from prior work by Google and Gallup's on access and barriers to computer science in K-12 schools (Google, 2015). In particular the survey items included whether they believe computer science to be as important as other subject areas, role of computer science in K-12 and students' lives, importance on computer science placed by key stakeholders (teachers, guidance counselors, school board, parents, and students), what CS opportunities exist in their schools, and what barriers to offering CS exist in their schools? (See Appendix A. for the complete survey).

The survey was distributed to the school leaders through multiple statewide organizations mentioned below:

- Michigan Association of Superintendents & Administrators (MASA)
- Michigan Elementary & Middle School Principals Association (MEMSPA)
- Michigan Association of Secondary School Principals (MASSP)
- Michigan Association for Computer Users in Learning (MACUL)
- General Education Leadership Network (GELN)
- Regional Educational Media Center Association of Michigan (REMC)
- Michigan Math and Science Leaders Network (MMSLN)
- REMC Instructional Technology Specialists (RITS)
- Michigan Educational Technology Specialists (METS)
- Code.Org listserv
- Computer Science Teachers Association (CSTA - Michigan Chapter)

DEMOGRAPHICS

One hundred and forty-two school leaders from Michigan completed the survey. The majority of the respondents were from larger school districts in Michigan with (30%) from Class A (enrollment 863 and above) and (32%) from Class B (enrollment 395-862). Class C respondents formed (19%) of the sample and (11%) were from Class D (8% of the participants were from other categories, including private and charter schools). In addition, (47%) of the participants were from rural schools, (30%) from sub-urban, and (11%) from urban schools. The survey participants included (18%) superintendents, (15%) high school principals, (9%) middle school principals, and (11%) elementary school principals. Participants also included curriculum directors (10%), technology directors (10%), and teachers (7%). Eighteen percent were from other categories, such as data assessment, math, and science consultants, and learning coach. Figures 1-3 show the breakdown of demographics.

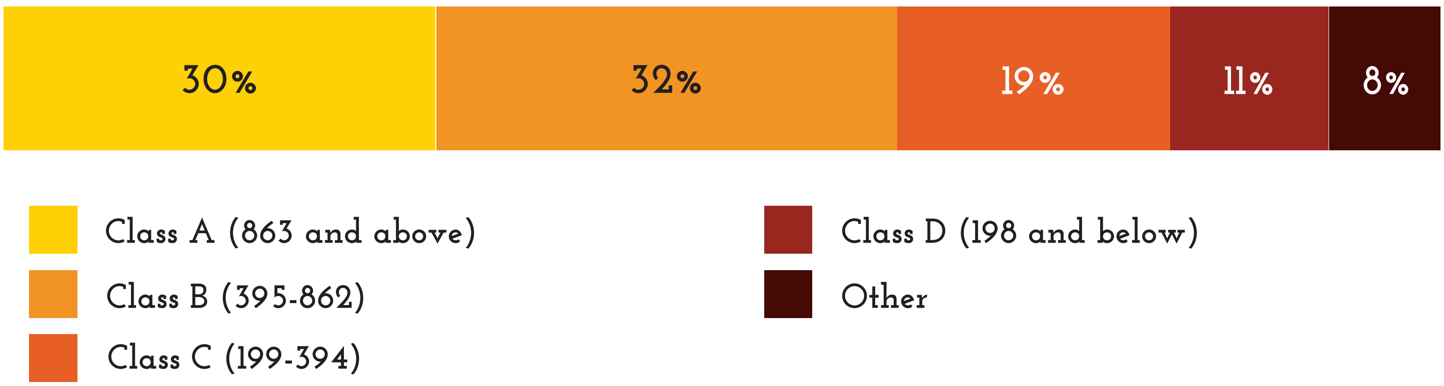


Figure 1: High School classification of survey respondents

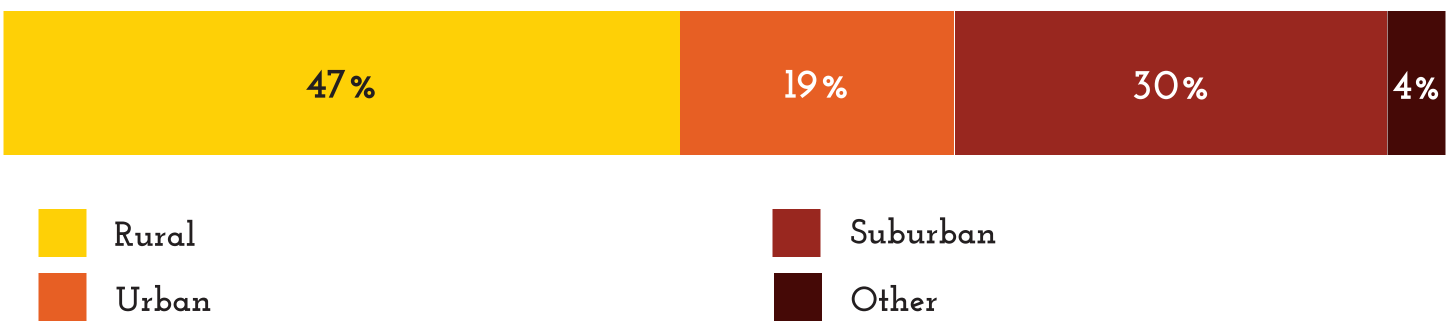


Figure 2: School Type of survey respondents

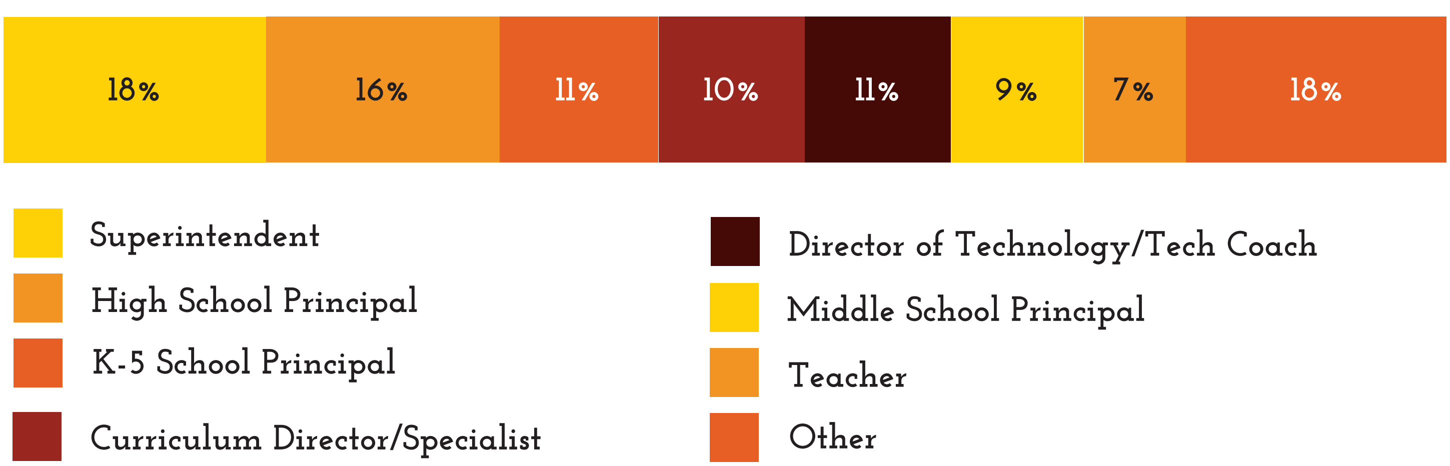


Figure 3: Role of survey respondents in schools

FINDINGS

IMPORTANCE OF COMPUTER SCIENCE COMPARED TO OTHER SUBJECTS

The survey asked the participants to rate whether computer science was less, more, or just as important as some of core K-12 subject areas. It is interesting to note that the majority of the respondents felt that computer science was just as important as math (64.1%), English (54.9%), science (70.4%), social studies (62.7%), foreign language (54.2%), arts (69.0%), health and wellness (71.1%). However, a significant portion of the respondents felt that it was less important than English language (38%), mathematics (29.6%), and science (21.1%) while they believed it to be more important than foreign language (35.2%), arts (23.9%), and social studies (16.2%).

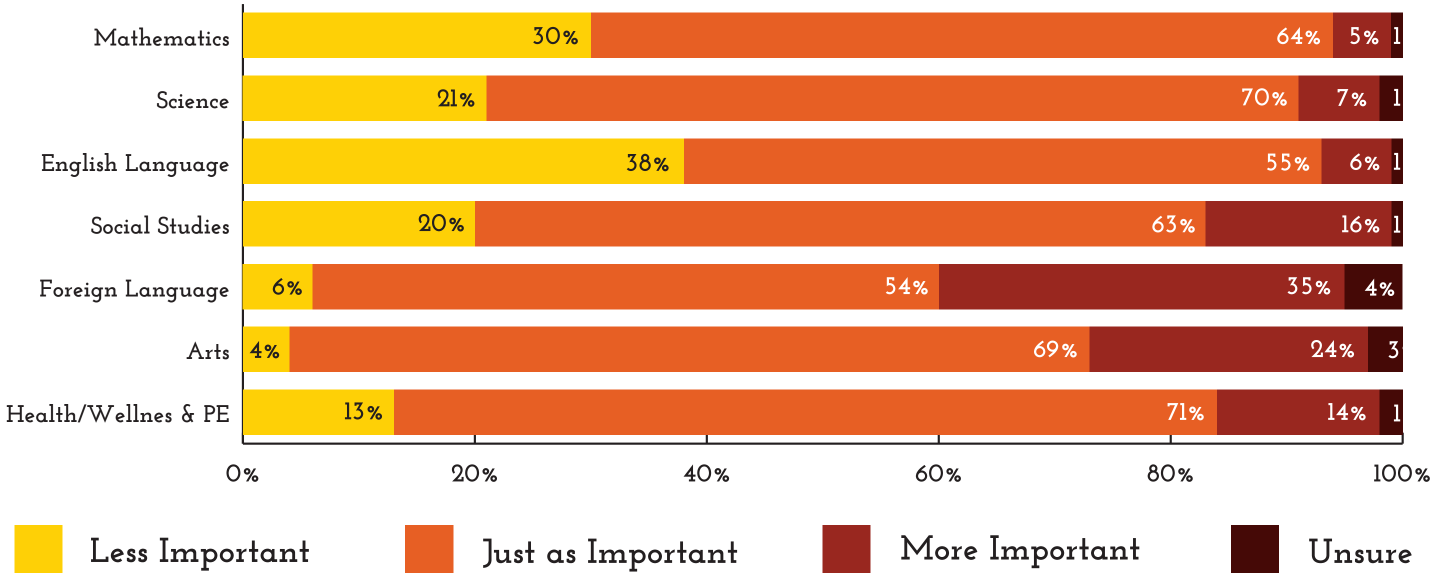


Figure 4: Importance of computer science vs other subjects

ROLE OF COMPUTER SCIENCE IN K-12 AND BEYOND

When responding to the question whether most students should be required to take a computer science course if it is available in their school, the majority of the participants (69%) agreed while only (17%) disagreed with it. Similarly, a significant majority (84%) of the participants also believe that it would be a good idea to try to incorporate computer science education into other subjects at school and (13%) disagreed with it. Ninety percent of the participants also reported that knowledge of computer science could be used in a lot of different types of jobs and only (6%) believed CS was not useful.

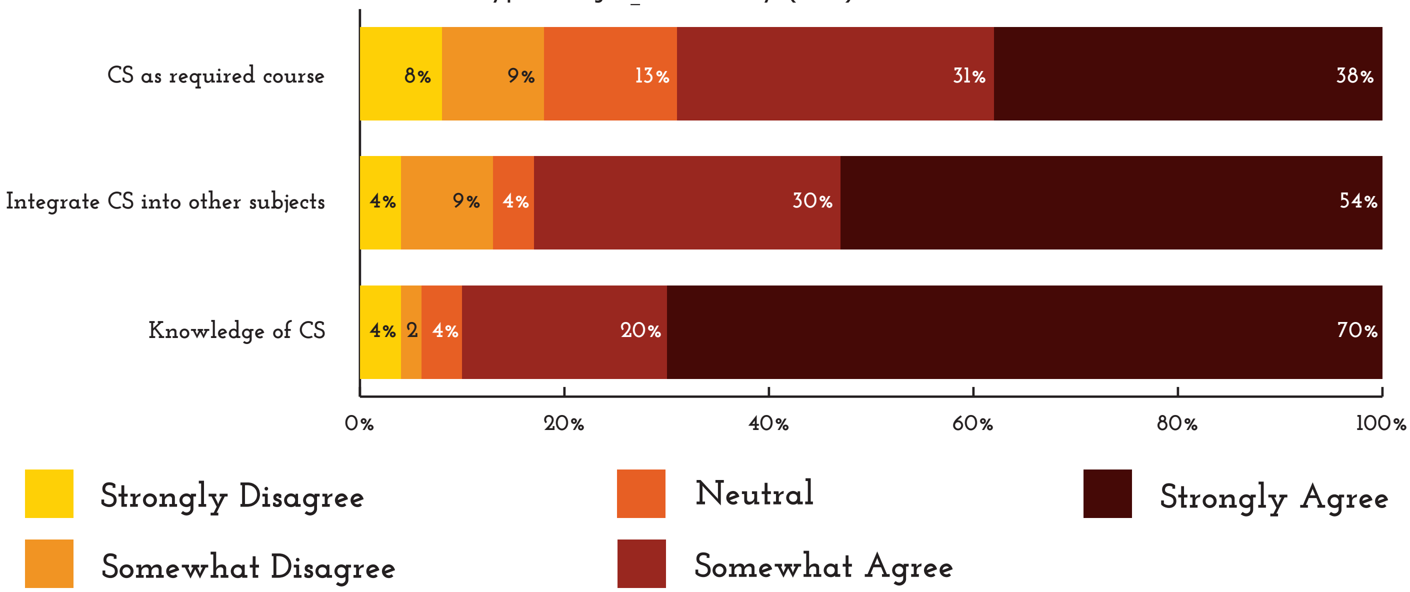


Figure 5: Role of computer science in K-12

When examining the role of CS in K-12, it is interesting to note that responses between urban, rural, and suburban school leaders differ. As seen in figure 6 below, a higher percentage of school leaders from urban school believe that CS should be a required course (58%), be integrated into other subjects (63%), and that knowledge of computer science could be used in a lot of different types of jobs (75%).

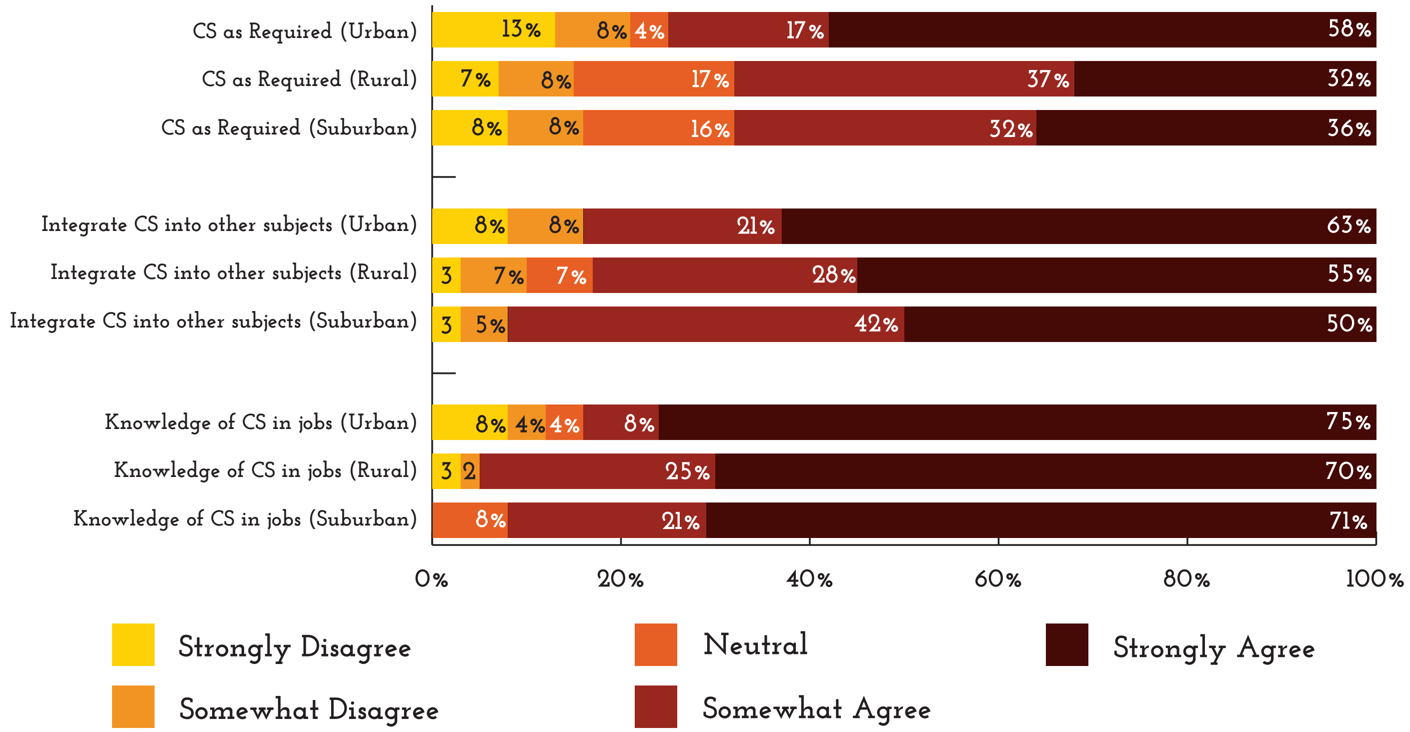


Figure 6: Role of computer science in K-12 (school leaders)

STAKEHOLDER OPINIONS

The survey asked school leaders about the importance key stakeholders (teachers, guidance counselors, and school board) placed on computer science as well as whether CS was a priority in their schools. The participants reported that (41%) of the teachers at their school thought it was important to offer opportunities to learn computer science and (25%) did not believe that teachers thought it was important. Only (35%) of the participants reported that guidance counselors in their schools thought it was important to offer opportunities to learn computer science. It was interesting that the majority of the participants (55%) believed that their school board was committed to offering computer science in their schools. However, only (30%) reported that computer science education was currently a top priority for their school/district while (39%) did not believe it was a priority.

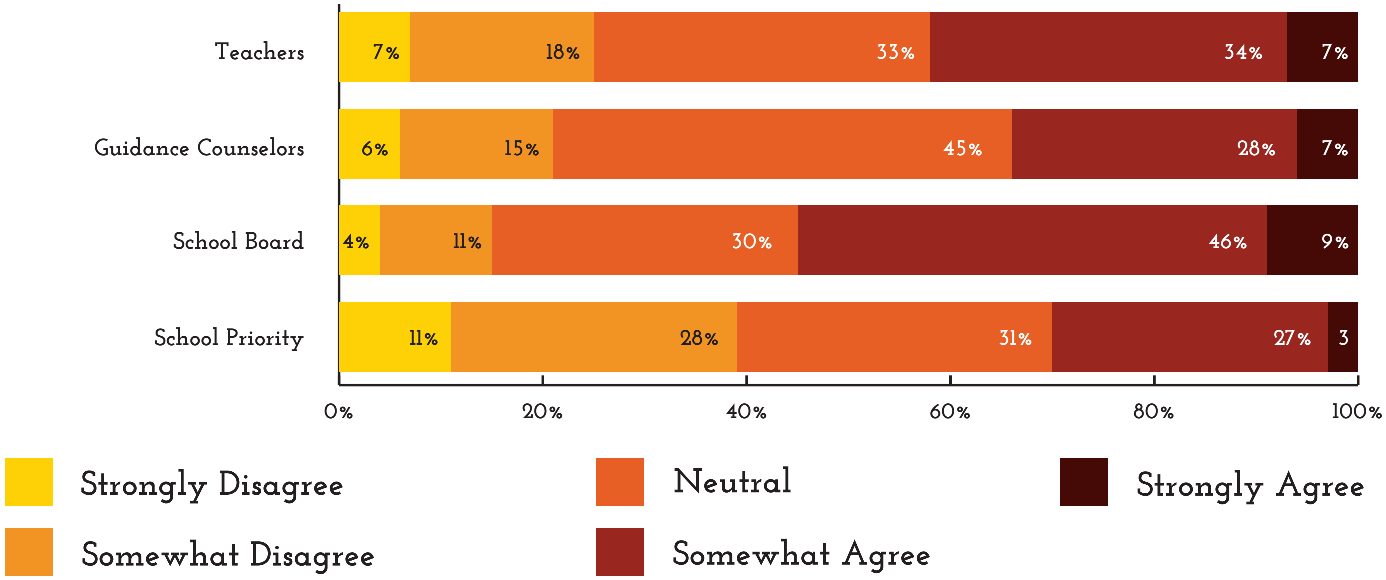


Figure 7: Stakeholder opinions on importance of CS

DEMAND FOR COMPUTER SCIENCE

When asked about demand for computer science from parents, (38%) of the respondents reported that there was low demand, (32%) believed that there was moderate demand, and (8%) believed there was high demand (note 23% responded they did not know). For demand among students, (27%) reported a low demand, (47%) reported a moderate demand, and (15%) believed there was high demand.

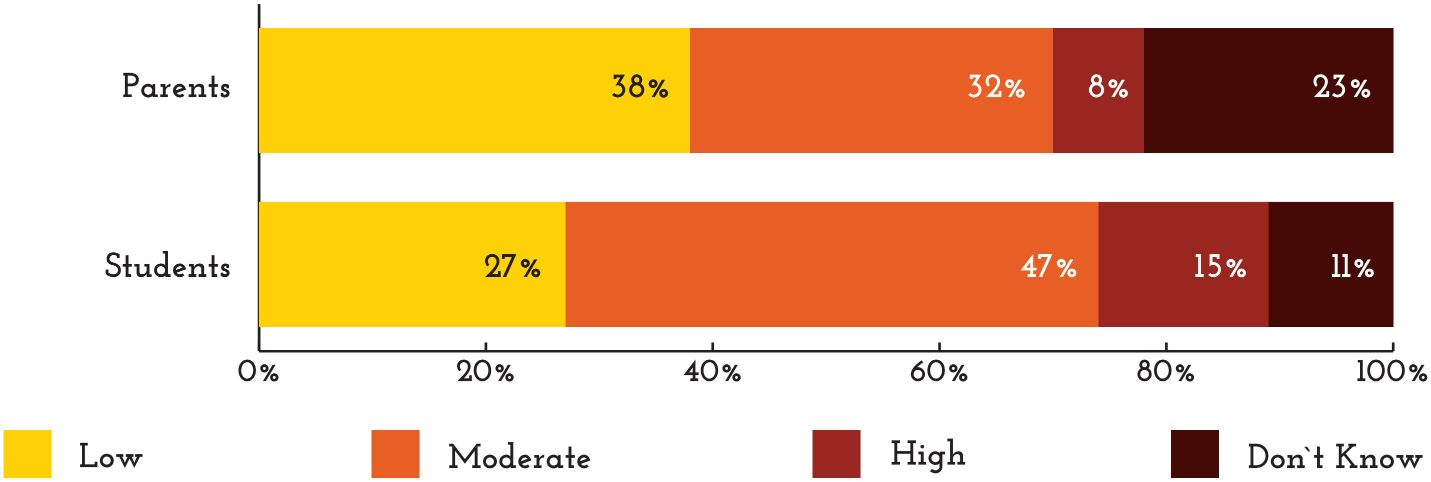


Figure 8: Demand for Computer Science

When examining differences in the demand for CS from parents and students from urban, rural, and suburban schools, we notice clear differences. While the majority of the urban school leaders didn't know the demand for CS from parents (33%), it is interested to note that (13%) of them believed that there was a high demand for CS compared to (5%) of rural school leaders and (8%) of suburban leaders. See figure 9 below for a detailed breakdown on school leaders' belief in the CS demand from parents and students in urban, rural, and suburban schools.

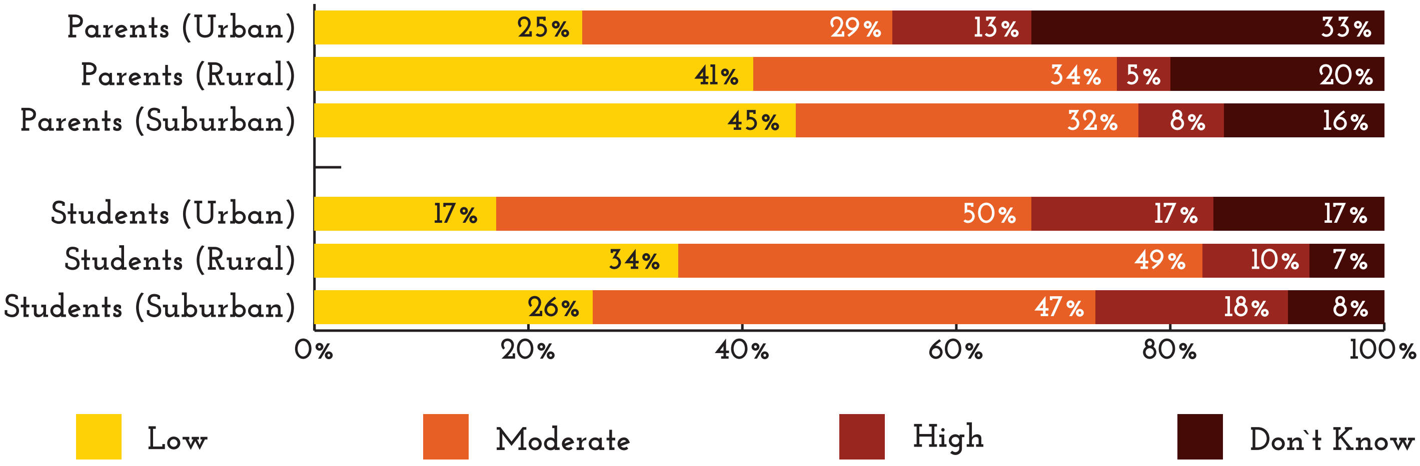


Figure 9: Demand for Computer Science by School Type

COMPUTER SCIENCE OPPORTUNITIES

We also surveyed participants whether formal and informal computer science opportunities existed in their schools. When asked how many different types of computer science (such as, programming/coding, robotics) courses were available in their school this year, (24%) reported 3-4 courses, (29%) reported 2-3 courses, (30%) reported 1 course, and (12%) reported that their school did not offer any CS course. In addition, (40%) believed that their schools offered 2 or more school-sponsored clubs or after-school activities that exposed students to computer science (such as programming/coding, robotics) in their schools while (16%) reported there were no after-school CS opportunities.

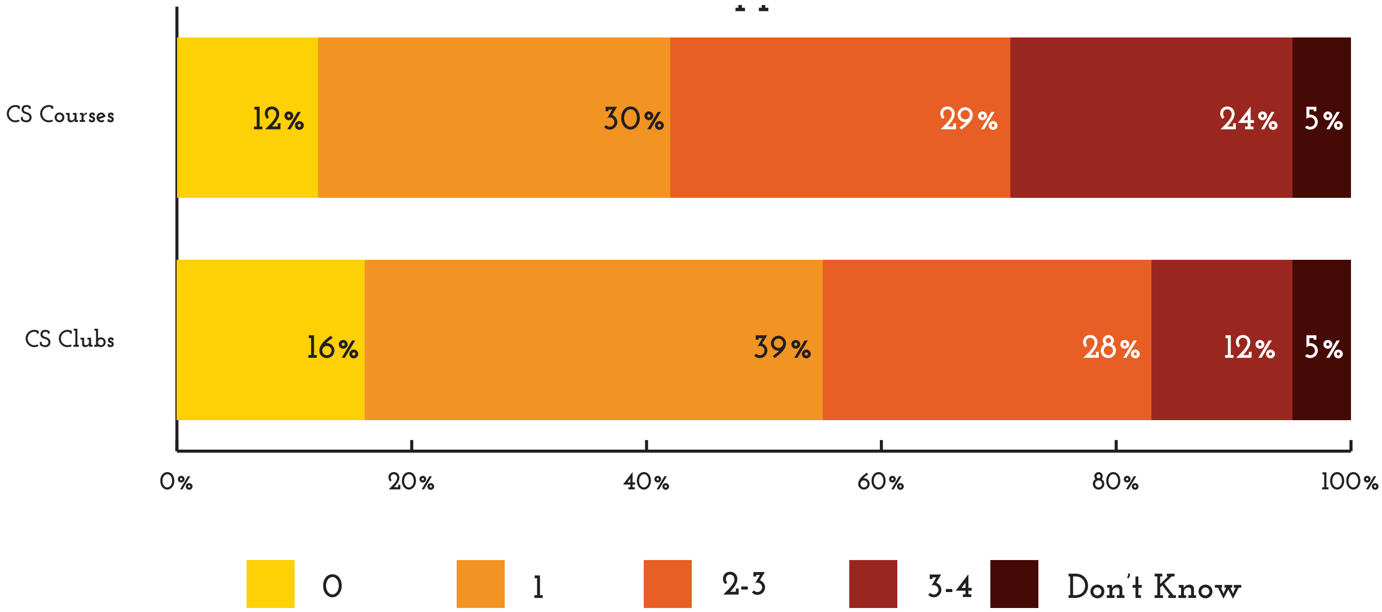


Figure 10: Number of CS opportunities

When disaggregating the number of CS opportunities by school type, we see that rural schools have the fewest opportunities with (15%) of the respondents reporting that their schools had no CS courses and (18%) responding that there were also no CS clubs in their school districts. See Figure 11 for a detailed look into the number of CS opportunities by school.

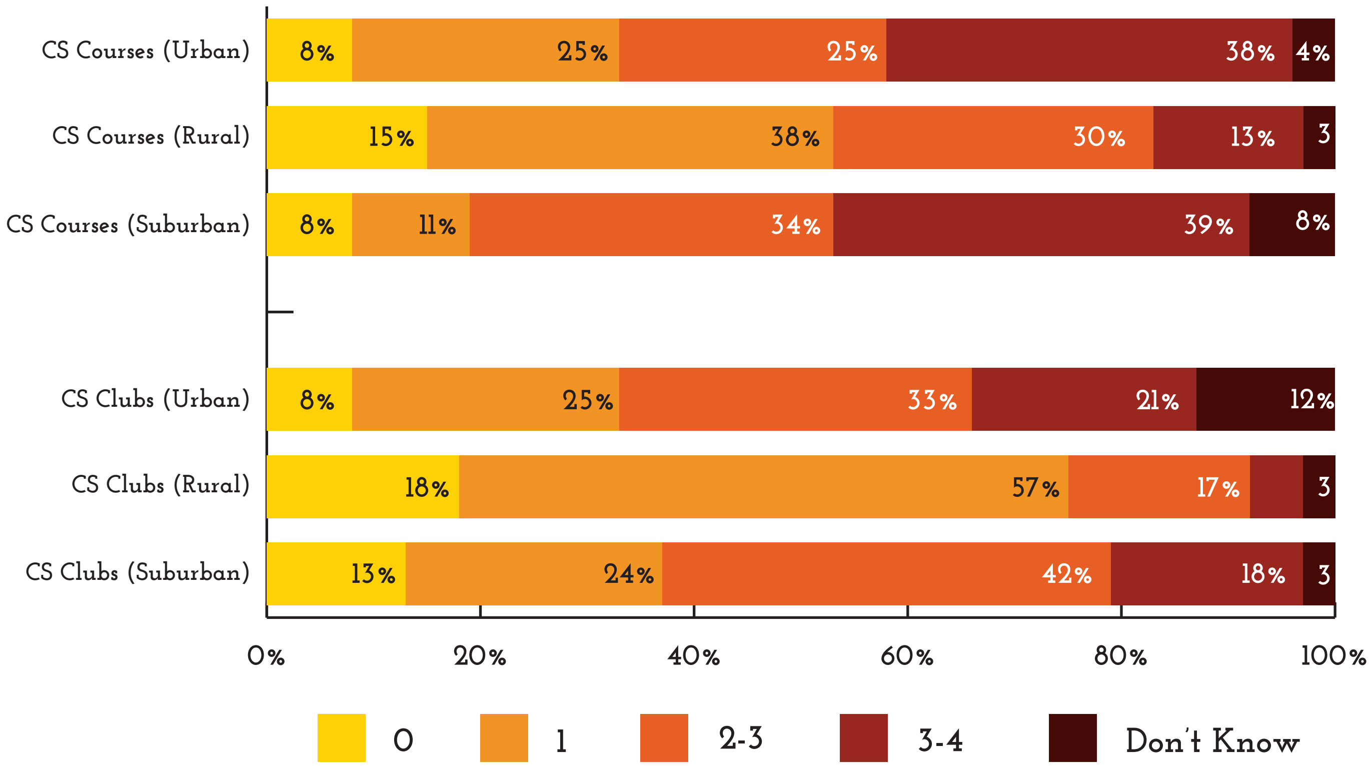


Figure 11: Number of CS opportunities by school type

We also asked participants what kinds of computer science opportunities existed in their schools. Figure 12 shows what participants believed were the opportunities in their schools (note respondents could select multiple options). What is interesting to note is that 97 respondents selected computer applications (such as, Office tools) as a computer science opportunity. This suggests that there are still misconceptions about what computer science is.

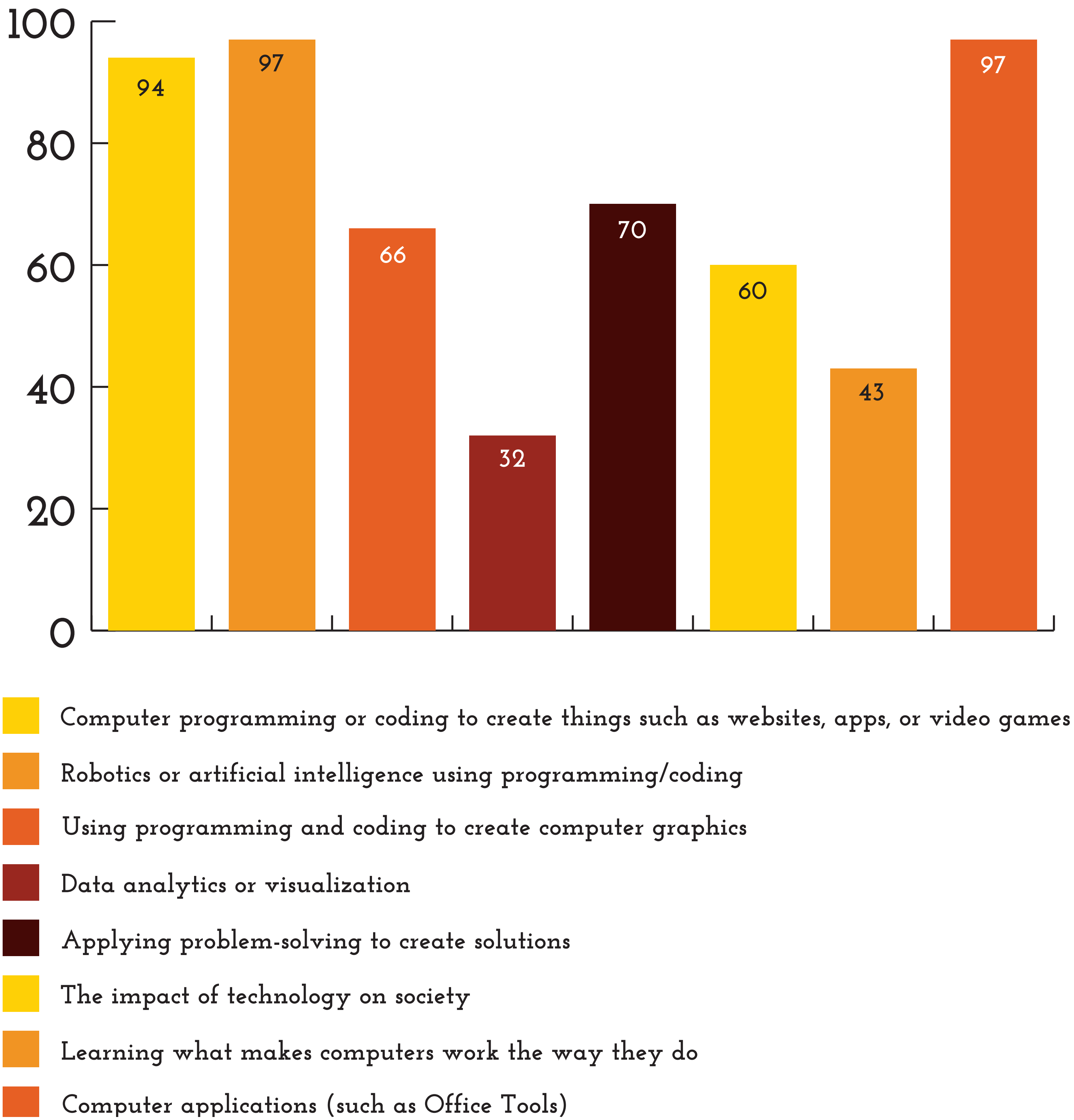


Figure 12: Kinds of CS opportunities

REASONS FOR NOT OFFERING CS

A small number of participants responded to reasons why their schools did not offer computer science. One of the main reasons that emerged was lack of necessary computer equipment and software or the budget to purchase. In addition, some participants (N=9) also reported that lack of time in the curriculum due to testing or need for students to take other courses in preparation for college was a barrier. Number of participants also reported that either lack of funds to train/hire a teacher (N=8) or lack of teachers in district (N=7) were barriers to providing CS opportunities in their school.

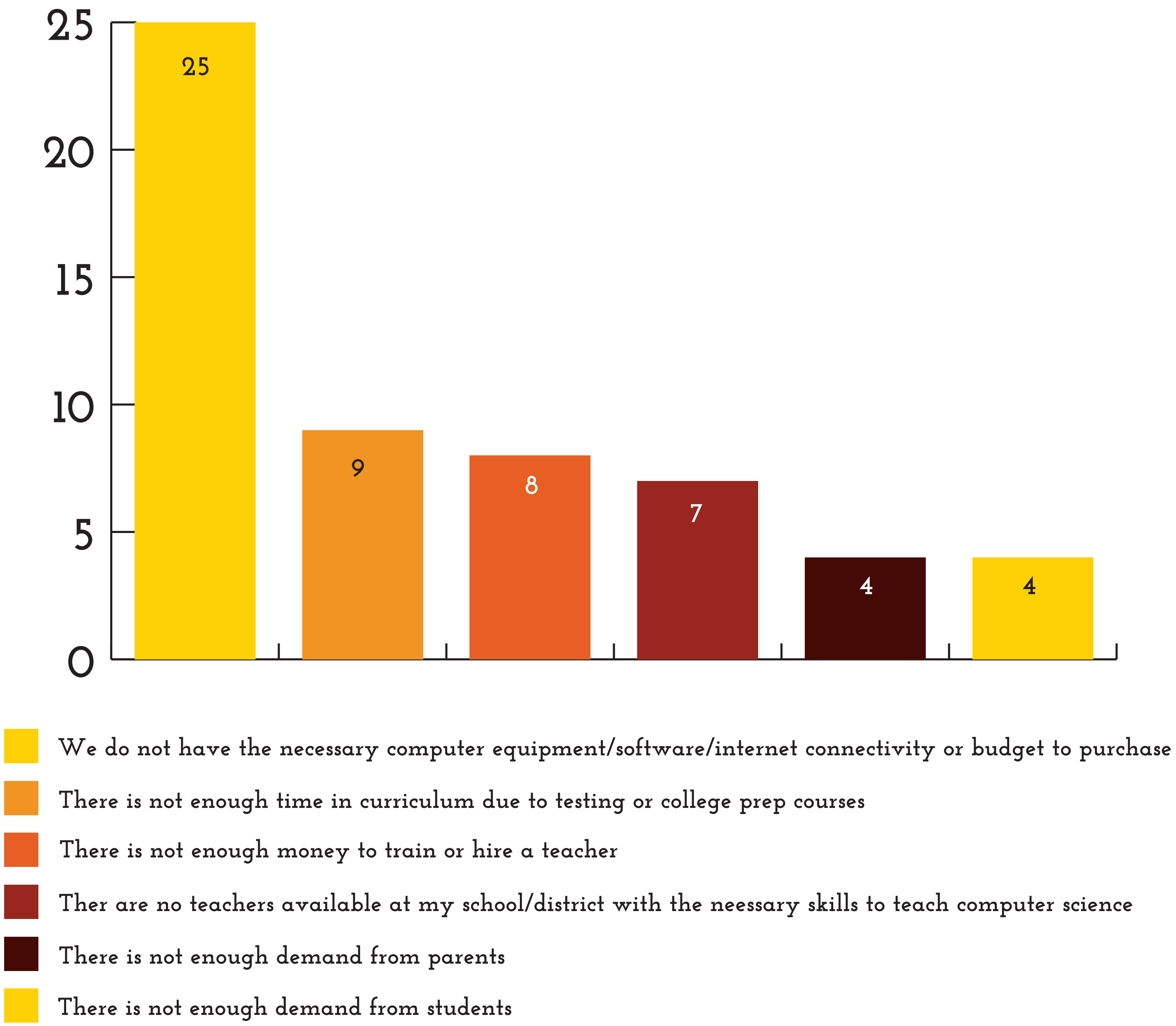


Figure 13: Reasons for not offering CS

ADDITIONAL MICHIGAN COMPUTER SCIENCE COURSE ENROLLMENT DATA

In addition to perceptions of school leaders about CS offering, we also examined CS course enrollment data at the elementary, middle, and high school level.[1] Code.org is the main curriculum provider that offers computer science stand-alone courses at the elementary level (CS foundations), middle school (CS discoveries), and high school (CS principles). Data for Code.org course offerings from Michigan suggests that majority of the schools still do not offer stand-alone CS courses at the elementary, middle, or high school level. At the elementary level 47.3% of the rural elementary schools, 53.6% of elementary schools in towns, 53.9% of sub-urban elementary schools, and only 35.8% of the elementary schools in cities offer computer science. The trend of declining course offerings continues at the high school level where even fewer high schools offer CS courses. Code.org course offering data suggests that only 22.3% of rural high schools, 25.7% of town high schools, 26.2% of sub-urban high schools, and 20.4% of city high schools offer CS. The numbers drop significantly at the middle school level where only 17.9% of rural middle schools, 22.2% of town middle schools, 15.1% of sub-urban middle schools, and 11% of city middle schools offer a CS course. Table 1 below shows the breakdown of CS course offerings in Michigan by locale. Table 2 further shows the breakdown by locale and Title 1 status of schools.

Table 1: Code.org CS course offerings in Michigan by locale

Grade Level	Rural	Town	Suburb	City
No CS	688	334	905	638
Elementary CS	249	133	406	168
Middle School CS	126	64	139	62
High School CS	93	44	97	43

Table 2: Code.org CS course offerings in Michigan by locale and Title I status

Grade Level	Rural Title I School		Town Title I School		Suburb Title I School		City Title I School	
	No	Yes	No	Yes	No	Yes	No	Yes
No CS	250	438	152	182	442	463	205	433
Elementary CS	53	196	29	104	166	240	38	130
Middle School CS	32	94	24	40	74	65	15	47
High School CS	31	62	19	25	70	27	18	25

Project Lead The Way (PLTW) also offers computer science in Michigan at the elementary, middle, school, and high school level. At the elementary (preK-5) and middle (grades 6-8) school level, PLTW CS offerings include exploration of computing as a part of Launch and Gateway curriculum respectively where students learn about some aspect of computing at each grade level in addition to other STEM topics, such as science and engineering. As such, PLTW CS offering are not stand-alone courses like Code.org; hence, we have separated PLTW CS offering as shown in Table 3 below. The PLTW high school CS offerings include four stand-alone courses: CS Essentials, CS Principles, CS A, and Cybersecurity.

Table 3: PLTW CS offerings in Michigan

Course Level	Rural	Town	Suburb	City
Launch CS	45	20	167	100
Gateway CS	3	10	18	27
CS Essentials and CS Principles	1	1	7	4

1 Note that the course enrollment data is from public schools with NCES ID.

SUMMARY OF FINDINGS

At the state level, Michigan Department of Education has made progress in adopting CS standards and also convened a group of key stakeholders (K-12 educators, school leaders, university faculty, industry partners, and key educational organizations) to inform the implementation of CS at the elementary and secondary level. However, as our findings suggest, there remain barriers to CS education at the state, school, and student level. We highlight some main findings below.

MAIN FINDINGS

- Not all students in Michigan have equal access to computer science courses and opportunities
- Many participants hold misconceptions about computer *science* (ex. CS = office tools)
- Lack of funds to buy equipment and train/ hire teachers remain barriers to offering CS

UNEQUAL ACCESS TO COMPUTER SCIENCE EDUCATION

One of the main findings is that not all students in Michigan have equal access to computer science courses and opportunities. As seen previously, a higher percentage of rural school leaders reported that their schools either did not offer any computer science courses (15%) or only offered one course (38%). In addition, they also reported that there were no informal computer science opportunities at their school (18%), such as clubs or only had one such opportunity (57%). This is in sharp contrast to urban and suburban schools where only (8%) of school leaders reported that they had no CS courses with another (25%) urban schools reporting one CS course and (11%) suburban schools reporting one CS course. This finding suggests that not every school is currently offering computer science opportunities at the same rate.

DIFFICULTY IN DEFINING COMPUTER SCIENCE

When asked about kinds of computer science opportunities being offered in their schools, it was surprising to see that there remain misconceptions of what computer science is with 97 respondents selected computer applications (such as office tools). This not only calls into question whether the number of CS opportunities being reported in schools might be inflated since using office productivity tools is not the same as using computational tools (such, as coding) to solve problems. At another level, this shows the need to educate school leaders on what computer science is and what it is not if we are to increase CS opportunities for Michigan students. Given the importance of CS for workforce needs as well as a 21st century literacy, we need to make this a priority.

COMPUTER SCIENCE IMPLEMENTATION ISSUES

While fewer participants responded to what they see as challenges to computer science implementation in Michigan, we still see some trends. Specifically, school leaders see the lack of funds to buy and/or update hardware and software as one of the main reasons for not offering CS. In addition, they see the time being devoted to tested subject areas as well as lack of funds to hire/train a teacher as other main barriers. In addition, many school leaders see CS as less important when compared to core subjects, such as math (30%) and literacy (38%).

CONCLUSION AND RECOMMENDATIONS

Given the landscape of Computer Science education in Michigan, there are four recommendations to prioritize CS education implementation in the state. Based on the survey findings, the first recommendation involves building awareness around CS education in Michigan to better define what CS, CS courses, and CS opportunities exist. The second recommendation proposes to build collaborative partnerships with local and national organizations to expand CS education in Michigan. The third recommendation is to increase CS resources for CS professional development and build CS teacher capacity in the state. Finally, recommendation pushes for the incentivization of CS implementation at all levels of funding to support districts that implement CS education. Below are specific action steps for each recommendation.

KEY RECOMMENDATIONS

- Build awareness for CS Education in Michigan to clearly define CS, CS courses and CS opportunities.
- Build collaborative partnerships with organizations to expand CS Education in Michigan.
- Increase CS Resources for CS professional development and build CS teacher capacity.
- Incentivize CS implementation at all levels for funding to support districts that implement CS education.

Recommendation 1: Build Awareness for CS Education

1. Define CS, CS courses, and CS opportunities as a first step toward building awareness around CS in Michigan. This includes communicating examples of CS in everyday life, and the role of CS in 21st century careers.
2. Pay special attention to key stakeholders (administrators, guidance counselors, teachers, school board, students, parents) to increase awareness around CS, with a CS career guide, for instance.
3. Explore communication avenues to share CS Education information through:
   - Summit
   - Newsletters, Social Media
   - CS Website (TechPlan.org or another CS-related website)
   - Work with partner organizations
4. Reclassify courses to distinguish between courses that are purely computer science courses and courses that are computer-related.
5. Collect data at the school-level to gather better understanding of course offerings, teacher expertise, student enrollment, and exam pass rates (secondary). Other data sources to explore are: Code.org, Project Lead The Way, MI Data Hub.
6. Showcase the integration of CS into existing courses through vignettes and case studies.
7. Create and share a "CS Asset Map" displaying CS resources available in different areas such as curriculum, professional development, and clubs to grow a CS network of educators.

Recommendation 2: Build Collaborative Partnerships

1. Expand CS Education in Michigan (communication, opportunities, and resources) by partnering with organizations such as:
   - MACUL: CS Summit
   - CSTA
   - MiSTEM Network: collaboration around tools/resources/playbooks
   - Michigan Virtual, Edupaths: courses
   - REMC: Professional Development
   - Others such as Code.org, Project Lead The Way, Higher Education Institutions

- RITS: Expand resources
- Library of Michigan
- MEMSPA/MASSP
- NCWIT
- TEALS
- SME PRIME Schools Initiative

2. Engage industry partners to promote internships, apprentices, job-shadowing and other student work-based learning opportunities.
3. Share ECEP applications when open to help increase the number of computing and computing-intensive degree graduates, and the diversity of those graduates through educational pathways.
4. Encourage teachers and leaders to join CSforALL to help schools and districts provide all students with rigorous K-12 computer science education.
5. Increase multi-state collaboration to build CS resources and CS opportunities in Michigan.
6. Create a diverse group of CS leaders across the state to help implement the present recommendations.
7. Create a cohesive rollout plan to ensure that all districts address CS in a comprehensive way.

Recommendation 3: Increase CS Resources

1. Build CS teacher capacity through micro-credentialing or competency-based credentialing.
2. Work with partner organizations to find and create OER CS resources that can be integrated into various content areas as well as provide CS crosswalks with subject areas (ex. Early Literacy).
3. Provide CS training resources for educators and the development of a CS Toolkit where users can find information and resources for CS implementation.
4. Promote CS opportunities for students (after school clubs, competitions, etc.).
5. Develop and share CS stories to showcase how CS is being implemented in Michigan.
6. Actively engage higher education institutions in the development of pre-service and in-service teacher trainings.
7. Encourage the development of new CS courses.

Recommendation 4: Incentivize CS Implementation

1. Incentivize districts that implement CS (submit K-12 comprehensive plans that include CS Vision, CS student pathways, CS data submissions, etc.) with competitive grants to increase opportunity for districts that are at a disadvantage (rural, socioeconomic, etc.).
2. Incentivize educators to integrate CS into their classes with CS professional development, micro-credentialing, or competency-based credentialing.
3. Incentivize districts that implement CS by bestowing distinction of “Blue Ribbon” CS District and promoting in various ways such as on district transparency (for public viewing).
4. Encourage collection of student participation data in CS through data collected from districts to provide accurate information of what courses are offered, how many students are enrolled and completing them by promoting with CS communication tools.
5. Solicit CS data submissions that would require districts to report CS courses offered, student demographics of those taking courses, successful course completion (secondary) and student demographics by promoting with CS communication tools.

6. Showcase implementation exemplars or examples of how CS can be integrated into existing courses (K-12) by promoting with CS communication tools.
7. Ask legislature for sustainable funding to implement recommendations, as well as seek grants and other funding opportunities.

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