Daniel Garcia

Stacey Suver

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Literature Review on the Inclusion of Computer Science in K-12 Curriculum

The inclusion of computer science in the K-12 curriculum for students has been an interesting topic debated over by many teachers, parents, states, and districts in recent years. Simply put, there have been many cases made for and against the idea of exposing kindergarteners to high schoolers to the concept of coding and programming within the subject of computer science. To further emphasize the relevancy of this topic in today's world, during the winter of January 2016, ex-president Barack Obama launched the "Computer Science for All" Initiative by providing schools more funds as high as $4 billion for states and local districts in order to allow for more opportunities to teach Computer Science across the country. As the world moves further up in terms of technological advancement, it's important for millennials and other generations alike to realize that the subjects offered in the educational curriculum and what students gain from those subjects are what shape up the new leaders in the future. The consensus of those who support the idea of including computer science in the K-12 curriculum believe that it will lead to a breakthrough of individuals with stronger problem-solving skills and sharper mindsets when finding solutions, especially in a day and age where technology is the standard norm for businesses and corporations. However, many of those who are against the idea of including computer science in the K-12 curriculum explain the challenge of a lack of individuals unwilling or incapable of

effectively teaching the subject to younger students, as well lacking the resources required to teach the course in primary and secondary schools.

The general argument in calling for a K-12 curriculum in computer science by advocates was that it would help strengthen problem-solving skills and deepen students' conceptual understanding in the field of math and science. Vinton G. Cerf, the vice president and Chief Internet Evangelist at Google also known as one of the founding fathers of the Internet, stated in an article back in March 2016 that computer science as a whole is all about analyzing problems and breaking them down into manageable parts, finding the results to those smaller parts, and then merging those parts into one big solution, which are invaluable skillsets and thinking strategies that apply to a plethora of other fields such as business, engineering, and even politics.[1] On the premise of younger students, Cerf is saying that if children were to learn these different types of skillsets early on in their career, they can tackle much more difficult problems in their future with ease since they will already know how to approach such problems and from which angle they should approach it on. He is also making the argument that because computers, smartphones, and tablets are much more accessible for the newer generations, having computer science in the curriculum will attract more students to careers involving computing. From a social, cultural, and economic standpoint, computer science in the curriculum will also lead to an increase in producers and inventors in the field of computer technology as well as an increase in technology-driven worldwide exports. Based on an excerpt from an article written in July 2016 by University of Tasmania computer science professor Andrew Fluck as well as other IT (Information-Technology) professors from various universities across the world, there are strong rationales for driving computer science into the curriculum. Because the world is now driven by technology with exports

[1] Cerf, Vinton G, "Computer Science in the Curriculum," Communications of the ACM, vol. 59, no. 3, 25 Mar. 2016, pp. 7–7., doi:10.1145/2889282.

of computer and information services seeing an increase from 9% to 32% in a decade and imports seeing an increase from 6% to 28%, the demand for individuals with experience in the field continue to grow for many industries around the world. Because of this economic drive, society is now emphasizing the participation of active creators and producers seeking to change how the world operates through technology rather than consumers who wait for these technological advances and innovate based on what's already laid out in front of them. This social rationale in turn enforces the rationale of having the younger generation be the leaders of cultural change, of imposing new local values and customs to the newer generations rather than being passive and waiting for change to happen.[2] The three rationales are all connected in the bigger picture since any two cannot exist without the presence of the other rationale. For example, if the world economy today was not so driven by technology, there would be no drive to produce more individuals in the field of technology, which would mean new customs and values would not need to be implemented for the future generations. If students were more exposed to computer science early in their career, it would further boost the development of technology and computer-related products worldwide.

On the other side of the scale, those who oppose the idea of having computer science be placed in the K-12 curriculum all agree that there is a lack of teachers qualified to teach younger students the subject of computer science effectively as well as a lack of funding by schools in running another STEM-related course. From an article written in September 2013 by German computer science professors Maria Knobelsdorf and Jan Vahrenhold from the University of Hamburg and University of Münster respectively, despite the fact that there are rigorous and effective Computer Science teacher training programs across the world, not a lot of teachers are

[2] Fluck, Andrew, et al, "Arguing for Computer Science in the School Curriculum," Journal of Educational Technology & Society, vol. 19, no. 3, July 2016, pp. 38–46., eds.a.ebscohost.com.proxy.library.stonybrook.edu/ehost/pdfviewer/pdfviewer?vid=1&sid=40065b08-0844-41c1-b353-8ff6e35ee931%40sessionmgr4008.

attracted or drawn in by the profession in the first place, leading to a lower number of teachers that are not enough to meet the market demands for computer science teachers. Due to this, schools often find themselves recruiting professionals that are not qualified to teach computer science, either with the fact that they have no experience in computer science or are just not well versed in teaching younger students.[3] Furthermore, even if teacher trainees receive an excellent formal education in computer science, it would still be hard for most of them to teach and break down smaller topics to elementary and middle school students since the caliber of primary school students are not yet well adapted to the level of teachings and techniques normally taught in computer science. Adding on to this, computer science professor Mark Guzdial from the School of Interactive Computing at Georgia Institute of Technology stated in an article back in August 2014 that because the US is so far behind in other STEM subjects compared to the rest of the world, the addition of computer science in the curriculum would only do more harm than good to the US's educational system. Guzdial also highlighted that for every ten high schools in the US, only one has computer science teachers, and even if this number were to be increased in the near future, the remaining teachers who have no expertise at all within the field of computer science would not even have any idea as to what they should be teaching and testing students.[4] These two articles are connected since they all come back to the general idea that there are not enough teachers teaching or are willing to teach computer science to new students, and because of this, the need of including computer science in the curriculum becomes more abstract. Another challenge that teachers face, and is mainly the reason why many deviate from learning computer science in the first place, is the lack of funding schools are receiving for training teachers. Based on an article written in August

[3] Knobelsdorf, Maria, and Jan Vahrenhold, "Addressing the Full Range of Students: Challenges in K-12 Computer Science Education," Computer, vol. 46, no. 9, Sept. 2013, pp. 32–37., doi:10.1109/MC.2013.263.
[4] Guzdial, Mark, "Why the U.S. is Not Ready for Mandatory CS Education," Communications of the ACM, vol. 57, no. 8, 1 Aug. 2014, pp. 8–9., doi:10.1145/2632036.

2017 by Jennifer Wang, the Research Program Manager on Google's Computer Science Education Team, many schools did not offer computer science classes because there was a lack of qualified teachers needed to teach the course as well as lack of funding from the schools needed to train these teachers in the field of computer science. The lack of funding for teachers was a statement that was agreed upon by 55% of the principals and 57% of the superintendents of these schools.[5] Funding becomes the main driving force in this challenge since teaching computer science to students has to be a well-sustainable occupation for many professionals, and if there is not enough to pay these professionals the amount of money required to make a living, then there is no reason as to why these professionals and teachers would even deviate to teaching computer science in the first place. A majority of the argument based on these three articles stem from the idea that schools and teachers just don't have the driving force to move forward with including computer science in the K-12 curriculum due to lack of resources, making the inclusion of the subject in the curriculum far more distant.

The case studies in the topic of including computer science in the K-12 curriculum have many individuals that advocate for and against the idea towards the future generations. This signifies that the debate to this day is still divided amongst many professionals in the field, yet further discussion would bring light to this debate even more compared to previous years. However, as the world shifts more towards technological advancement, so will the sides that support and oppose the inclusion, and research can only see an upward trend from here as more people will be able to see the effectiveness of computer science in the curriculum.

[5] Wang, Jennifer, "Is the U.S. Education System Ready for CS for All?," Communications of the ACM, vol. 60, no. 8, 24 Aug. 2017, pp. 26–28., doi:10.1145/3108928.

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