A Cross-Case Analysis of Experienced Educators in CS Inclusion

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ABSTRACT

Educators should provide access to all students with inclusive and equitable computer science (CS) and computational thinking (CT) learning outcomes. Yet access to CS and CT is not always available for students with disabilities. This qualitative cross-case study examined the barriers and strengths three exemplar teachers faced, explored the supports and resources they provided, and presented how these teachers defined successful inclusive CS learning outcomes for their students. The data set included analysis of the semi-structured teachers' interviews and teaching materials. The results included seven successful strategies the teachers identified: 1) using physical computing, 2) pair programming, 3)connecting CS and Individual Education Plans (IEP), 4)applying hands-on activities, 5) CT integration, 6) using CS vocabulary, and 7)open-ended pedagogy. Three resources and supports the teacher provided emerged from the data set as follows: 1) accessible instructional materials, 2) projects with multiple entry points, and 3) essential scaffolding supports. Whereas four barriers teachers faced; 1. subject matter, 2) accessible tools, 3) students receiving support, 3) the role of CS in instruction, and 4) the role of time served as additional findings. The results suggested that school-based practitioners, including administrators, can overcome the barriers and promote successful strategies that lead to asset-based CS-inclusion in the classroom.

CCS CONCEPTS

• **Applied computing** → **Education**; • **Human-centered computing** → **Accessibility**.

KEYWORDS

CS Education, Special Education, Inclusion, Accessibility

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1 INTRODUCTION AND PROBLEMS

Providing all K-12 students equal access to computer science (CS) education has become an emerging topic, especially for students with disabilities[6]. Most of those students who received special education service were taught alongside their peers in general educational settings [2]. Although studies suggested additional supports and appropriate instructions that enabled students with disabilities to be successful in CS education, there is a lack of practical pedagogical approaches to provide inclusive CS education[2, 3, 5]. Our study aimed to uncover how experienced teachers provide inclusive CS education to students with disabilities and what barriers they face during implementation.

2 METHODOLOGY

This study is a cross-case study[4] which investigated how three exemplar practitioners provided inclusive education for their students. Three educators 1 were purposefully selected for a 45-minute Zoom interview. The interview protocol included ten questions and related probes, which were developed to develop a deep understanding of educators' CS-inclusion implementation. Four researchers were involved in the Zoom interview process. One researcher asked interview questions, while the other three researchers observed and took notes based on the teachers' answers. Data analysis included the transcription of the three teachers' interviews, operationalizing codes based on teachers' interviews, and analyzing across three cases. To ensure inter-rater reliability, two researchers coded twenty percent of the data together to develop a norming protocol. They then coded the remaining interviews separately. When finished the coding process, the two researchers discussed and solved the differences together.

Pseudonym	Grade	Class Setting	Roles
Sarah	5	Inclusive Co-taught	Special ed
Emily	6-12	Inclusive Teaching	General and Special ed
Jennifer	K-6	Inclusive Teaching	CS facilitator

Table 1: Teachers Information

3 RESULTS

As Figure 1 showed, there were three successful strategies all teachers used in their schools: physical computing, pair programming, and connecting CS with IEP goals. And all of them agreed with using multiple entry points in CS instruction. However, there were various resources and barriers they encountered in the classroom.

		Sarah	Emily	Jennifer
Successful Strategies	Physical computing	x	x	x
	Pair programming/Small Group Instructions and learning	x	x	x
	Connecting CS with IEP Goals	x	x	x
	Use of hands-on activities	x		x
	Integration into other subject areas		x	
	Use of CS vocabulary			x
	Open-ended Padegogies		x	x
Resources	Lending libraries			x
	Essential Scafolding supports		x	x
	Multiple Entry points	x	x	x
	Accesible Instractional Materials		x	x
Barriers	Unclear role of CS	x	x	
	Students not receiving supports.		x	x
	Limited tools			x
	Time consuming		x	x

Figure 1: Teachers' Strategies, resources, and their Barriers.

3.1 Case 1: Sarah

Sarah is a special education teacher who taught 5th-grade students with autism. Her school district had a designated computer science period for each school. Thus, she utilized this time and let her students join the general classroom to learn the CS curriculum together with non-disabled peers. Physical computing, pair programming, and hands-on activities are three instructions to facilitate CS learning for students with disabilities. Notably, she found her students with autism could perform as a leader during paring programming, compared to their usual shyness in social situations. To better facilitate students' learning process, Sarah provided them with multiple entry points to start their CS-related projects. Sarah also connected IEP goals with their CS learning and emphasized the importance of making students with disabilities accountable. Although Sarah provided different supports and resources to include all students in her classroom, the unclear role of CS was a significant barrier for her students. Sarah believed students needed to know the purpose of their CS learning, which could better engage them and help them learn.

3.2 Case 2: Emily

Emily started her CS teaching career after taking a constructionism [1] course, encouraging her to apply the open-ended pedagogical approaches within CS. She valued the role of open-ended pedagogy and integrated CS into different subjects through open-ended projects. In addition, she used physical computing and pair programming to engage her students. For example, her students with disabilities often competed in programming competitions involving physical computing challenges in their local school district. Emily's efforts in providing support were the secret to these students' successful learning processes. Emily engages her students in accessible learning content with multiple entry points. Although these supports took her a long time to prepare, Emily insisted everyone should have opportunities to access and retain knowledge. Coincidentally, Emily also combined CS and IEP goals. The difference was she used it to connect CS with other subjects, although she was not asked to measure students' success through the IEP plan. For example, Emily aligned a sixth-grade geometry lesson that connected a student's math goals with the class's work with Scratch. Even though Emily shared so many inclusive things with us, the unclear role of CS frustrated her in her teaching process. She suggested the administrators reexamine CS's role in policy and provide teachers with more resources for an inclusive education.

3.3 Case 3: Jennifer

Jennifer had a similar opinion to Sarah and Emily that physical computing and pair programming were two representative strengths for students with disabilities in elementary-level CS learning. She used Bee-bot, Coding creditor, and Code-a-Pillars for physical computing. At the same time, Jennifer checked with families to ensure students could learn with these tools at home. To teach CS better in the classroom, Jennifer provided students with four supports: 1) different entry points for students to learn, 2) various types of assessment for students to represent themselves, 3) essential scaffolding supports, and 4) small group instruction. What surprised us was she also used open-ended projects based on CS standards. She applied it to measuring students' success in CS learning. For example, Jennifer designed an open-ended assignment for fourth graders to complete. Students could choose different ways to demonstrate competency in meeting the CS standards.

4 CONTRIBUTIONS TO FUTURE WORK

This work elucidates successful instructional strategies, resources, and barriers for CS inclusive education. The findings provide K-12 special education teachers with successful teaching strategies, which could help them replicate inclusive instructions in their school settings. In addition, this study indicated that administrators should consider the role of CS in the K-12 environment and provide district-level support for special education teachers. Furthermore, this study suggested future research should investigate how to utilize the resources for inclusive CS education, such as scaffolding or technology tools.

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