# BOARD # 70: Instructor Practices for Supporting Neurodivergent Students in Undergraduate Computer Science Courses: Neurodivergent Faculty and Student Perspectives

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# WIP: Instructor Practices for Supporting Neurodivergent Students in Undergraduate Computer Science Courses: Neurodivergent Faculty and Student Perspectives


## Abstract

Neurodivergent student needs often differ from neurotypical students in Computer Science programs, resulting in higher attrition rates. To combat this, we must understand how different teaching practices impact these students' learning. In this exploratory study, we use an interpretive phenomenological inquiry approach to explore neurodivergent student (n=3) and neurodivergent instructor (n=2) perspectives through interviews and focus groups throughout a semester to understand their experiences with and recommendations for inclusive practices. Our findings demonstrate that a combination of practices is required to support these students.


## Introduction

Computer Science instructors can better teach neurodivergent students when they have the necessary training to enhance learning and belonging for these students [1]. *Neurodiversity* is a term that captures how natural, biological variation in neurological development is a fact and benefit of the human population [2], [3]. Here, we include any neurominority within the term *neurodivergent*, including, but not limited to, autism, dyslexia, and mental health disorders [4], [5]. Neurodivergent conditions are often classified as disabilities because of the internal and external circumstances that impede an individual's learning and quality of life in existing systems [6]. Individually or in combination, neurodivergent conditions impact physical health, well-being, social and academic life, including irregular sleep patterns, seizures, and physical or sensory disabilities [7]. K-12 supports are advancing with increased accessibility, diagnosis, and neurodivergent awareness. Therefore, the number of neurodivergent students enrolled in post-secondary institutions is increasing [8]. Neurodivergent students show high interest in STEM programs and demonstrate logical, systematic, and creative thinking, in addition to strong visual-spatial skills, systems thinking, and pattern recognition [8], [9].

Neurodivergent students tend to leave undergraduate courses more than their neurotypical peers, including courses in Computer Science [10]. Instructors also receive little to no guidance or neurodiversity training on how to help students with disabilities outside of accommodations [11], even when their goal is to facilitate a support system for students' learning, belongingness, and success [12]. In this study, we sought to explore neurodivergent instructor and student perspectives to understand their experiences of supportive learning practices. We chose this group to capture the perspective of individuals who are both aware of the impact of neurodiversity and can provide unique insights into instructor and student roles. The research team interviewed both neurodivergent students and neurodivergent instructors in undergraduate Computer Science programs over a semester, both individually and in focus groups. We present the results of these discussions here, organized into categories based on existing research on pedagogy and instruction. Our research elucidates how specific types of practices have impacted neurodivergent students from both instructor and student perspectives. We conclude with recommendations for targeted training areas that support mastery of the student role and sense of belonging in undergraduate Computer Science courses.

## Background

Building learning ecosystems for neurodivergent Computer Science students requires implementing more inclusive practices, instructor accountability, and curricular design to improve student success. In post-secondary education, providing specific teaching practices to support neurodivergent learning needs fosters an authentic Computer Science identity, sense of belongingness, and constructive learning experience in their course domain [13].

Moreover, neurodivergent student ways of knowing and approaches to learning in STEM, particularly science and mathematics, are fundamentally connected to their background, identity, and existing worldviews [14], [15]. The reality for many neurodivergent students is that academic systems are not designed for how their minds or bodies work [16], resulting in a need for rethinking and adapting instructor teaching practices. Doyle [17] argues that a reasonable estimate for neurominorities within the world population in 2020 is between 15 and 20%. This estimation represents a significant portion of the population, but the percentage will increase as researchers get closer to the real number. Marginalized populations, including non-male or Black, Indigenous, and other People of Color in Computer Science, may not have a diagnosis because testing accuracy is lower for women and BIPOC populations [18]. Historically, research in the United States on testing for neurodivergent conditions was shaped based on the behaviors and experiences of white males [19], [20]. While the exact numbers are unknown in each classroom, every Computer Science class is neurodiverse, meaning that the way instructors teach and provide support must account for neurodivergent students.

Neurodivergent student voices are underrepresented in educational STEM research and pedagogical research is mainly focused on learning and instructional practices effective for neurotypical students; conducted by neurotypical researchers [21]. Without neurodivergent perspectives in research, we fail to provide teaching support that adequately accounts for the challenges these students face in undergraduate education. For example, in the United States, the typical expectation is that students will have diagnoses, visit their accommodations office or some equivalent support office, present evidence of a disability, and receive a specific list of supports to then request from instructors [22]. Occasionally, the accommodations office sends a notice to the instructor on the student's behalf to obtain the accommodation. In post-secondary education, it is essential to ensure that instructors have evidence-based neurodiversity training on the support their students need and ideally increase the graduation rates of neurodivergent students [22].

## Methods

In the Spring of 2023, we interviewed three undergraduate neurodivergent students and two neurodivergent instructors (n=5) on their lived experiences in Computer Science using an interpretive phenomenological inquiry approach [23], [24]. To ensure participants responses reflected their honest perceptions about their classes, we conducted private open-ended interviews, beginning with a single question to ask whether they felt their neurodiversity had impacted their experiences in their classes in any way. It was up to students to schedule interviews when they felt they had something to share, and they could leave at any time; consequently, interviews ranged from 5 to 45 minutes. In this study, participants reported single or multiple types of neurodiversity, including autism, Attention-Deficit Hyperactivity Disorder, dyslexia, and/or depression. The neurodivergent Computer Science students were white and queer (Avery), Black and queer (Imani), and South Asian (Kushal). The instructors both identified as male and white (Robert and Tim). Pseudonyms are assigned to all research participants [25]. Fewer participants in an interpretive phenomenological approach allows for profound and multifaceted descriptive in-depth analysis of each individual experience of the practices discussed [26].

*Data Analysis*

Both authors used an inductive thematic approach to identify broad themes and categories that emerged from the participants' detailed accounts without predetermined codes that may lead to the exclusion of participant perspectives [27]. The first and second author worked together to inductively derive results during analysis. Constant reviewing and team discussion of the patterns in the data showed emergent themes that enabled further exploration and definition [28]. Firstly, we "chunk" the data structurally into broad topic areas and eliminate interview data that did not discuss participants' experiences with teaching practices [29]. The second step is to subcode the "chunked" data focused on examples of the teaching practices, including short phrases like "providing multiple forms of the same lecture." In the third step, we review all the subcodes to combine them into three major themes: best practices, inclusive practices, and neurodivergent-specific practices [30]. *Practices* are actionable recommendations or practices teachers could use that teachers or students believe could improve learning and inclusion for neurodivergent students. We present these themes in turn, sharing student and instructor experiences as they correspond to external supports in each teaching practice.

**Table 1. Example Subcodes and Categorization**

| Quote | Subcode | Theme |
|---|---|---|
| "You can use all sorts of different data sets; [they] appeal to different people [by] letting them see how it's relevant in their life." | *Teach material relevant to student life and recruit interest* | Best Practices |
| "So if I lecture, at least I can provide the material in a couple of different ways, and they have a video then that they can go back and look at, they have something." | *Providing multiple forms of the same lecture to match student preferences* | Inclusive Practices |
| "There are a bunch of policies that I created specifically, I think, that will help everybody, but targeting, well, me [and] a certain type of neurodivergents in particular." | *Specific policies for neurodivergent learners in syllabus* | Neurodivergent-Specific Practices |

**Results and Discussion**

In this section, we present each practice theme derived from participant responses, beginning with the most broadly applicable approaches. Neurodivergent student perspectives on practices reflect existing literature on best practices and inclusivity, but there is a weight to the categories they think are most crucial. Our participants focused on effective communication, student engagement, individual attention, and sensory friendly environments. Aspects of these are found throughout all three existing categories of support and the training instructors can seek.

*Best Practices Support Learning for Everyone*

Computer Science student Imani explained that they feel motivated when the learning is interesting, authentic, and engaging in the classroom:

> Trying to find like that value, they may put it in the syllabus or in the beginning like, hey, these are the learning outcomes. This is what you're gonna be learning from it. This is how it's gonna apply to your future career. So that might be some way they're trying to get that interest. Like, hey, this actually does matter.

Here, Imani proposes a variety of best teaching practices that include creating well-defined, straightforward learning objectives in the classroom policy and stating how the learning material is relevant to students. These practices stimulate interest and establish application to their Computer Science field and careers. Instructors can guide student learning to develop technical skills and demonstrate the expected education objectives by teaching the value or purpose of the computing curriculum.

> Professors often do not provide a clear idea of what material is covered and when, which complicates planning. If there were a clearer definition of topics covered on a calendar, then it would be simpler to plan.

Avery, a Computer Science student who told the team they identify as having Attention-Deficit Hyperactivity Disorder, reflects on frustrating experiences with the ambiguity of the instructor's delivery. Instructors with disorganized class schedules, syllabi, and course context caused Avery to question their sense of belonging in the program. Instructors should provide their students with a clear delivery of explanations and design the class to have organized planning and content structure. Drummond [31] claims the best practices that facilitate student learning needs include clarity and course organization, climate setting, fostering learner responsibility, and goals to grade connections. Instructors must be intentional with their teaching methods and performance to foster an inclusive and safe learning environment for open communication, collaboration, and belonging that evolves with student needs [32].

*Inclusive Practices Support Diverse Classrooms*

Most of the practices students and instructors focused on aligned with frameworks for inclusivity; for example, suggesting multiple ways of communicating lessons is both good for effective communication in diverse classrooms and advocated for as *multiple means of representation* in the Universal Design for Learning (UDL) [33], [34]. Although we did not study or test an ideal framework in this research, the UDL framework was used as an example in the focus groups to guide the conversation [35]. Providing options for representing knowledge is central to effective communication [36]. As Robert, a neurodivergent Computer Science instructor who describes himself as dyslexic, explained:

> When I have a student who's like, 'Are there slides or is there something else to work off of?', I make sure to point them to [the other instructor] and his material and be like, 'If this is how you work, you should figure out what to do that helps you...'

By giving the students access to materials from other sections and instructors of the course, Robert is providing his students with alternative ways to build and access knowledge. Intentionally designing the Computer Science course with materials from more than one instructor gives students access to interact with the representation of the curriculum and/or instructional methodology that works for them. Subsequently, the student can master the expected knowledge in the domain [37]. This allows students to have the autonomy to choose which instructional style of teaching materials is best suited to support their specific learning style, needs, identity, perception, and perspective in the classroom [38].

*Neurodivergent Specific- Practices Supports Individuals*

Neurodivergent supports vary on a case-by-case basis and are not broadly applicable, as neurodiversity changes across classrooms and neurodivergent student needs are unique to the individual. Kushal, an autistic student who uses identity-first language, said:

> They were telling me to do an assignment about facial expressions, and it was probably a nightmare for me... I was lucky that they exempted me from it, but there [were] no clear guidelines for that, people who are autistic can get exempted... a person who has a proven record that struggles to read facial expressions can get exempted from this.

This is an example of the lack of policies that account for neurodivergent students who cannot complete assignments without assistance due to the unique nature of their neurodiversity. To account for the needs of individual neurodivergent students like Kushal, instructors can adopt practices to support Kushal's mastery of the assignment, such as providing alternative assignments and tests, tailoring assignments case-by-case to include neurodivergent students, and collaborating with accessibility resources and the neurodivergent community for feedback on assignments. Kushal also said that neurotypical instructors and teaching assistants lack understanding or connection on how he behaves and thinks as a neurodivergent student. He expressed a desire for more neurodivergent teaching assistants who would be personally familiar with his experiences.

Both neurodivergent instructors and neurodivergent students in Computer Science emphasize that a safe learning environment fosters supportive practices for student learning needs, identity, and neurodiversity [39]. The key to ecosystems of belonging starts with instructor-student relationships and maintaining awareness of the differences in neurotypical and neurodivergent communication [40]. The students should feel safe to self-advocate their learning needs to the instructor about what is going on in their learning, and the instructor can listen to develop more inclusive teaching strategies or policies for their neurodivergent student. Many of these practices may benefit all students, but it is critical to implement practices exclusive to the neurodivergent student learning experience. The instructor can decide which practices are helpful to effectively include their neurodivergent students in Computer Science and STEM, with flexibility in classroom policy and accepting accommodations offered by the training.

**Table 2. Summary of thematic codes**

| Theme | Definition | Practices from Literature |
|---|---|---|

| | | |
|---|---|---|
| Best Practices | General teaching practices are measurable effective actions to facilitate learning | Clarity and Course Organization, Foster Learner Responsibility [8], [13]. |
| Inclusive Practices | Pedagogical approach to provide instruction to the meet the needs and abilities of diverse learners, and strive to eliminate hurdles to learning in the classroom | Curriculum Design (open ended-projects), Guide Appropriate Goal Setting [16]. |
| Neurodivergent Specific-Practices | Recommendations our participants identified are helpful and specifically designed to improve learning and inclusion for neurodivergent students in Computer Science | Neurodiversity Professional Development Training [17]. |

**Future Work**

The results from the study suggest focus areas for instructor training. Observational research should study the impact on student belonging and learning after professional development focusing in particular on best, inclusive, and neurodivergent-focused practices that emphasize effective communication, student engagement, individual attention, and sensory friendly environments.

**Conclusion**

Creating belonging for STEM students with invisible disabilities calls for the ongoing efforts of instructors to educate themselves on teaching pedagogy. Instructors can start with learning best practices to support learning for everyone, study inclusive practices that support diverse classrooms, and work with students to identify neurodivergent-specific practices for individuals. Thus, we anticipate neurodivergent students with instructional supports designed to fit their learning needs will help them master the student role, contribute to the United States computational workforce, and participate in Computer Science and STEM career pathways after graduation.

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