From Pilot to Practice: Establishing Neuroinclusive Teaching Practices for Long-Term Impact

Ms. Connie Syharat, University of Connecticut

Connie Syharat is a Ph.D. student in Engineering Education and a Research Assistant at the University of Connecticut as a part of two neurodiversity-centered NSF-funded projects. As the Program Manager of a Revolutionizing Engineering Departments (NSF:RED) project titled, "Beyond Accommodation: Leveraging Neurodiversity for Engineering Innovation", she has co-facilitated a range of Neuroinclusive Teaching Institutes and workshops for STEM instructors and Teaching Assistants. As a graduate researcher, she conducts qualitative research related to the experiences of neurodiverse graduate students in STEM fields through an Innovations in Graduate Education (NSF:IGE) project titled, "Encouraging the Participation of Neurodiverse Students in STEM Graduate Programs to Radically Enhance the Creativity of the Professional Workforce". Previously, she spent eight years as a K-12 teacher in Connecticut, where she maintained a focus on providing a varied learning environment and differentiated instruction for all types of learners.

Dr. Sarira Motaref P.E., University of Connecticut

Sarira Motaref is an Associate Professor in residence in the Department of Civil and Environmental Engineering at the University of Connecticut. She is a licensed Professional Engineer in the State of Connecticut. She received her PhD in 2011 from the University of Nevada, Reno. She has been teaching junior and senior-level design courses, as well as several large-enrollment classes. Sarira is currently serving as Assistant Director of Faculty Development at the School of Engineering and Center for Excellence in Teaching and Learning (CETL) to enhance teaching and learning effectiveness of engineering courses. She is the winner of 2021 University Teaching Fellow award, 2019 Distinguished Engineering Educator Award, and recipient of 2016, 2017, and 2018 Klewin Excellence in teaching award.

Marisa Chrysochoou, University of Missouri - Columbia

Marisa Chrysochoou is the Dean of the College of Engineering at the University of Missouri. Before joining Mizzou, she served as Professor and Head of the Department of Civil and Environmental Engineering at the University of Connecticut (UConn). At UConn, she directed the EPA Technical Assistance for Brownfields Program, which supports communities in redeveloping contaminated properties, and the NSF-funded Revolutionizing Engineering Departments (RED) project titled "Beyond Accommodation: Leveraging Neurodiversity for Engineering Innovation."

Chrysochoou has been a member of the American Society of Civil Engineers (ASCE) Department Heads Coordinating Council since 2021. She was also recognized by the Association of Environmental Engineering and Science Professors (AEESP) in 2023 for her contributions to environmental engineering education.

Throughout her career, Chrysochoou has secured funding for various projects, collaborating with federal and state agencies, industry partners, and multidisciplinary academic teams. Her work has focused on environmental geochemistry, surface chemistry, the treatment and reuse of industrial waste, remediation of contaminated soils and sediments, brownfield redevelopment, and environmental justice. She has also worked on engineering education reform, emphasizing neurodiversity and service learning.

Chrysochoou has extensive experience working with government entities, program managers, and academic faculty across disciplines to develop partnerships that support research and innovation. As an educator, she has focused on creating experiential learning opportunities and adapting curricula to address modern engineering challenges.

From Pilot to Practice: Establishing Neuroinclusive Teaching Practices for Long-Term Impact

Abstract

The formation of a creative engineering workforce depends on the inclusion and retention of a diverse student body. However, the high reliance on traditional teaching methods, such as exclusive use of the lecture/exam format, in engineering classrooms may contribute to the underrepresentation of neurodiverse students whose unique strengths often go unrecognized and underutilized in undergraduate engineering majors. As part of an NSF Revolutionizing Engineering Departments (RED) project aimed at enhancing neurodiverse students' participation and sense of belonging in engineering, department faculty at the University of Connecticut School of Civil and Environmental Engineering engaged in a systematic effort to redesign core courses using a novel, strengths-based framework for neuroinclusive teaching. This framework centered on a) building a culture of inclusion, b) inclusive instructional design, and c) improved communication and supports. Guided by this framework, redesigned courses in the department showcased a wide range of innovative teaching practices, including strengths-based messaging about neurodiversity, flexible grading and course policies, multiple modes of assessment, and integrated student feedback loops. This paper uses a two-phase content analysis of data consisting of a) transcripts from semi-structured interviews with 9 faculty instructors, and b) course syllabi from each participant's redesigned course to investigate the perceived impact and sustainability of the neuroinclusive teaching practices implemented in these courses. The findings provide an inventory of the neuroinclusive teaching practices implemented by these faculty, the perceived impact of these interventions, and the challenges in sustaining these practices. This study has implications for faculty seeking to incorporate neuroinclusive teaching practices in engineering classrooms.

Introduction

Despite the urgent need to foster a more creative workforce, the traditional teaching methods, competitive culture, and "gatekeeper" courses so prevalent in undergraduate engineering programs [1] often screen out nontraditional learners. Yet these learners' ways of thinking have the potential to contribute unconventional and innovative approaches to address complex engineering problems [2], [3]. Engineering learning environments have often presented a mismatch for neurodiverse students whose ways of learning and socializing may differ from those of most students. Thus, neurodiverse students have remained underrepresented within engineering. Neurodiverse individuals are thought to make up around 20% of the general population [4]. However, studies indicate that they make up only 3-5% of undergraduate engineering students [5], [6]. These levels decline even further at advanced levels. Neurodiverse individuals comprise only 1 to 3% of students in graduate science, technology, engineering, and mathematics (STEM) programs [7]-[9] and less than 3% of the STEM workforce [10].

Even so, the past decade has seen the emergence of an increasingly robust body of literature challenging the deficit framing of neurological differences and highlighting neurodiversity-related traits that may be considered assets in STEM [11]-[14]. For example, ADHD has been linked to divergent thinking, risk-taking, and hyperfocus on tasks of interest [15]-[17], while

research has shown correlations between autism and strengths in pattern recognition and systemizing [18], [19]. Some studies also associate dyslexia with strong visual-spatial skills [20], [21]. Recent scholarship also examines how neurodiversity intersects with research integrity, social justice, and education [22].

Motivated by the understanding that traditional undergraduate engineering programs are failing to cultivate the strengths of neurodiverse learners, the Include Program was implemented at the University of Connecticut Department (now School) of Civil and Environmental Engineering, funded by the National Science Foundation Revolutionizing Engineering Departments (NSF:RED) program. Include aimed to build a more inclusive learning environment for a neurodiverse student body by making change across five main areas within and beyond the school: recruitment and transition, community building, teaching and learning, holistic support, and career preparation and industry outreach. Of these five areas, the focus on teaching and learning was found to have the highest potential for impact on the student experience. Since many neurodiverse students choose to not disclose their neurodiversity or have not yet self-identified as such [23], it can be challenging to identify and engage specific students who might benefit from personalized supports. In contrast, designing a more inclusive and supportive learning environment has the potential to enhance the learning experience for *all* students. For example, a specialized non-residential learning community for neurodiverse engineering students had enrollments between 6-11 students in each offering, reaching 24 students over three semesters. Meanwhile, redesigned neuroinclusive courses in the department reached 4,590 students across nine semesters of implementation (Table 1).

Table 1

	Year 1		Year 2		Year 3		Year 4		Year 5	
Semester	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
# Students	-	395	195	623	197	801	353	730	416	880
Yearly Total		395		818		998		1083		1296
5-Year Total										**4590**

Total students enrolled in redesigned neuroinclusive courses during the 5-year project.

This paper examines the project's efforts to transform teaching and learning within the school, with a focus on the impact and sustainability of teaching practices adopted by faculty as a part of a neuroinclusive course redesign process. In this study, we hope to answer the following questions: 1) What practices were adopted in redesigned neuroinclusive courses?; and 2) Were the implemented neuroinclusive practices sustainable, and why?

Background

At the university level and in federal law, educational policies relating to cognitive variations such as ADHD, dyslexia, and the autism spectrum are framed through a disability lens. Neurodiverse students who wish to access academic accommodations must obtain a formal medical diagnosis and then self-identify as a student with a disability [2], [23]. This process is fraught with barriers; women and girls are frequently undiagnosed or misdiagnosed, disparities

in diagnosis rates exist across racial and ethnic groups, and access to diagnostic services is mediated by income and access to health insurance coverage [24]-[28]. Additionally, a large percentage of students who received supports prior to college do not identify themselves to the university, choosing to remain silent about their experiences [29]-[33]. The "chilly climate" within engineering and other STEM fields may exacerbate these concerns [30], [34]. Neurodiverse students in STEM classrooms often face stereotypes and negative attitudes from faculty who may view them as unmotivated or perceive that they use accommodations to seek an unfair advantage [29], [35], [36]. Thus, neurodiverse students in engineering remain invisible within a rigid system that pathologizes cognitive differences, experiencing personal and academic distress, as well as high rates of departure from their programs. These challenges highlight the need for systemic change in approaches to teaching in STEM. The Include Program aimed to address this need by developing a strength-based framework for neuroinclusive teaching.

Development of a Strength-based Framework for Neuroinclusive Teaching

Cultural change was driven through professional development team known as the "I-Team" (the prefix "I" denotes "Inclusive"). The I-Team was comprised of school leaders, faculty, program staff, and experts from the Center for Excellence in Teaching and Learning (CETL) who worked together to navigate the course redesign process. Neurodiverse undergraduate and graduate students occasionally joined I-Team meetings to share insights based on their personal experiences in engineering courses. This team aimed to foster a sense of faculty ownership of the redesign process. First, faculty engaged in biweekly workshops and discussions on topics related to neurodiversity, instructional design, Universal Design for Learning (UDL), and inclusive teaching practices. Next, faculty moved into course development, applying "I-Course Standards" to revamp their syllabi and instructional strategies. Finally, the redesigned courses were implemented, and feedback was collected via student surveys.

Central to the process was the development of the "I-Standards," a rubric-style framework focused on strengths-based, inclusive teaching. These standards underwent iterative revisions and now serve as a guiding document for faculty designing I-Courses. The approach encompasses three main themes, all anchored in a strength-based approach toward neurodiversity, (1) Culture of Inclusion, (2) Teaching and Learning, and (3) Communication and Supports—all drawn from research on effective, inclusive teaching. Default interventions include providing accessible course materials, recording lectures with accurate captions, and introducing the project and basic information about neurodiversity to students through a brief presentation or video at the beginning of the semester. A brief description of these areas of focus is provided below. A more complete outlining of the I-Standards framework has been shared through the conference proceedings of the American Society for Engineering Education (ASEE) [37].

Culture of Inclusion

A key priority of the I-Course initiative is to build a broad culture of inclusion that goes beyond traditional efforts to support women and underrepresented minorities. Here, inclusion explicitly encompasses neurodiverse learners, defined broadly to include a range of neurological variations such as ADHD, autism, dyslexia, and anxiety. To promote this inclusive environment, faculty

introduce personalized inclusion statements in their syllabi or class introductions, clearly signaling their commitment to support diverse learning strengths and challenges. In addition, a brief orientation by program staff offers students basic information on neurodiversity and highlights campus resources related to accommodations, mental health, and wellness. The faculty development component of this involves neurodiversity and disability awareness training, and dialogues with campus partners. Instructors complete an inclusive teaching inventory, reflecting on how their courses address inclusive content, instructional practices, and student interactions.

Teaching and Learning

In addition to reinforcing key instructional design principles (e.g., clear articulation of learning objectives aligned with learning activities and assessments), the I-Team introduced faculty to Universal Design for Learning (UDL) principles. UDL encourages providing multiple ways for students to access content, engage in activities, and demonstrate their learning [38]. An emphasis on active learning further aligns with engineering's hands-on nature, while acknowledging strategies to accommodate students who may find group work or rapid-response activities challenging.

Communication and Supports

Finally, communication and supports are bolstered through practices like collecting regular student feedback and offering consistent outreach to underperforming students. Mechanisms such as live, shared course calendars and readily available supplemental resources encourage a sense of shared ownership of the learning process. By prioritizing regular instructor-student interactions, whether via office hours, virtual platforms, or brief social activities, faculty aim to foster connection and belonging among all learners. These measures, taken together, are designed to lessen the stigma around seeking support, empower neurodiverse students, and improve the educational experiences of all students.

Implementation of Neuroinclusive Teaching Practices

The project focused on redesigning undergraduate courses from two undergraduate programs: Civil Engineering and Environmental Engineering (CEE). Many of these courses are fundamental engineering classes that are taken by non-CEE majors. They are typically taken in the second, third, and fourth year of the program and have the enrollment range of 60-180 students per section. One goal of the redesign was to build flexibility into courses, allowing students to choose how they learn and demonstrate knowledge, thereby potentially reducing the need for formal accommodations. To achieve this, faculty modified class policies and assessments and offered content in multiple formats (online videos, lecture recordings, etc.). This approach not only aimed to minimize challenges that neurodiverse students face in traditional classrooms, but also to empower them to leverage their strengths in learning and assessment. This approach was embedded in the faculty experience, as well. I-Course instructors had the choice to adopt all or some of the recommended neuroinclusive practices, and they were encouraged to implement changes that aligned with their own teaching strengths and style.

Methods

Participants

The 9 participants in this study were recruited from the group of 16 faculty instructors of redesigned courses. The pseudonyms of each participant and the summary of participant demographics, including sex, race/ethnicity, and the main focus (research or instruction) of the faculty participants is found in Table 2. To maintain the anonymity of the participants, the pseudonyms used in the study are not listed in association with the name of the specific course taught.

Table 2. Summary of participant demographics

Participant (Pseudonym)	
Professor Bloom	
Professor Bolt	
Professor Craft	
Professor Field	
Professor Gauge	
Professor Lens	
Professor Muse	
Professor Spark	
Professor Twist	
Sex	
F	4 (44%)
M	5 (56%)
Race/Ethnicity	
White (Caucasian or Middle Eastern)	6 (67%)
Asian (East or South Asian)	3 (33%)
Faculty Focus	
Research	5 (56%)
Instruction	4 (44%)

Data Collection

Data sources included a) faculty interview transcripts, and b) redesigned course syllabi. After their implementation of the redesigned course, faculty were invited to schedule an interview with a member of the research team. Four of the faculty in this sample opted to participate in multiple interviews over the course of the project. This resulted in rich data about the course redesign process from faculty who delivered a redesigned course multiple times during the five-year

project. Any redundancies in the data from these interviews were eliminated in the content analysis, so that each faculty's course interventions were considered only once in the analysis. The transcripts were drawn from five rounds of interviews conducted with I-Course instructors over the course of the five-year project. Topics included understandings of neurodiversity, course interventions, the redesign process, interactions with students, and faculty experiences and perceptions. Example questions from the semi-structured interview protocol are included in Table 3.

Table 3. Summary of interview focus areas and example questions

Focus	Understandings of Neurodiversity
Example Questions	• What does neurodiversity mean to you? • What role has the concept of neurodiversity played in your experience as an instructor? • What are the key features of a neuroinclusive course? Why? • How would you explain the concept of neurodiversity now (Year 5)?
Focus	Course Interventions
Example Questions	• What are some of the aspects of the course that you have redesigned? • Why did you decide to implement these changes? • Have you changed, added, or removed anything about your redesigned course (since last year)? • What formats for delivering instruction have you used this year?
Focus	Course Redesign Process
Example Questions	• How would you describe the process of planning inclusive instruction? • What support or resources supported you in the redesign process? • What limits or challenges to inclusive teaching do you find in your particular course?
Focus	Interactions with Students
Example Questions	• Do you discuss neurodiversity with your students? How do they respond? • How did students respond to the changes that you made?
Focus	Faculty Experiences/Perceptions
Example Questions	• What motivated you to become involved in the project? • How did you approach your course redesign? • What, if anything, has surprised you this year/implementation? • What changes have been most impactful?

Drawing from both the syllabus and interviews allowed us to consider both the practices that were present in the syllabus as well as the faculty's observations and reflections about their redesigned course. We aimed to evaluate a) what course interventions were made, b) the perceived impact of these interventions, and c) whether the interventions proved sustainable. The

list of courses included in this study, along with their enrollment in the Fall semester in year 5 of the project, is presented in Table 4.

Table 4. Redesigned courses included in the sample

Course/Enrollment (Fall Semester – Year 5)	
Applied Mechanics I	173
Probability and Statistics in Civil Engineering	65
Mechanics of Materials	116
Construction Management I	85
Soil Mechanics	78
Design of Concrete Structures	22
Environmental Engineering Fundamentals	71
Fluid Mechanics	46
Engineering Hydrology	26

Data Analysis

A two-phase study was conducted, beginning with a qualitative content analysis and followed by a thematic analysis of faculty interviews to investigate the sustainability of course interventions in redesigned neuroinclusive courses. In the first phase, course syllabi were reviewed to identify all course interventions, and a comprehensive list of adopted changes was compiled. This process involved coding course modifications according to a priori codes developed from the I-Standards framework, ensuring consistency in identifying neuroinclusive practices. These codes were applied deductively, as they were based on predefined categories aligned with the framework's key principles. These included codes like "Accessibility," "Feedback," and "Active Learning." In the second phase, faculty interview transcripts were analyzed using the same predefined codes to anchor and elaborate on the findings from the first phase. The coding was conducted independently by two researchers to enhance reliability and minimize bias. Discrepancies in coding were discussed and resolved through consensus meetings, ensuring consistency and rigor in the thematic analysis. Findings from both phases were then synthesized to provide a comprehensive understanding of which neuroinclusive teaching practices were implemented, which were discontinued, and the underlying factors influencing these decisions.

Findings

The findings are structured according to the three main areas of focus: Culture of Inclusion, Teaching and Learning, and Communication and Supports. Example interventions are described in detail below and summarized in table format within each subcategory. Finally, a summary of the challenges noted by faculty in sustaining certain practices is provided.

Culture of Inclusion

We highlight here the most universally applied interventions related to a culture of inclusion: inclusion statement and strength-based language (Table 5).

Table 5. Summary of "culture of inclusion" interventions

Culture of Inclusion		
Intervention	Notes	N (%)
Inclusion Statement	Written in syllabus or delivered verbally in class, in addition to required university statement on disability and accommodations	9 (100%)
Strength-based language	Embedded in inclusion statement, one-on-one conversations with students	9 (100%)

Inclusion Statement

The requirement that faculty provide a personalized inclusion statement support's the project's aim to go beyond the basic requirement of the university that faculty provide reasonable accommodations and thus provide a more inclusive learning environment. All instructors teaching I-Courses include this statement in their syllabi. Recognizing that students may not thoroughly read the syllabus, some instructors preferred to share their vision verbally at the start of the class. Some faculty chose to mention additional aspects of student identity and/or experience. Professor Craft mentioned *"diverse backgrounds and perspectives (gender, sexuality, disability, age, socioeconomic status, ethnicity, race, national origin, language, and culture),"* while Professor Bolt added *"diverse perspectives,"* and Professor Field mentioned *"different levels of preparation."*

Strength-Based Language

Instructors adopted strength-based language, particularly during one-on-one conversations with neurodiverse learners. Professor Spark felt that *"the most important piece with all these trainings was messaging,"* saying *"that positive messaging can change the story. It can flip the scenario… rather than emphasizing – you're last minute, or you are a procrastinator. Rather, we emphasize… you have potential. You're creative… the field of engineering and STEM needs you…"* Other examples of this strength-based language may be seen in the previously mentioned inclusion statements found in the course syllabi. Professor Muse mentions *"diverse thinking styles,"* Professor Bolt mentions leveraging *"unique abilities in addressing complex engineering problems,"* and Professor Lens hopes that students will *"identify, develop, and apply their… strengths to activate motivation and accelerate learning."* Professor Craft said that *"the most impactful [change]"* was *"how I talk to my students,"* saying,

> *"now neurodiverse students, they come and talk to me… they actually open up… one student came to my office during my student hour... And then I asked them, How are the courses treating you this semester?And the first thing they said… Oh, I am a neurodiverse individual. So, your course is actually helping me…"*

Teaching and Learning

This section highlights 5 categories of findings related to teaching and learning: instructional design, accessibility, active learning, personalization, and course policies.

Instructional Design

Instructors of inclusive courses were encouraged to employ sound instructional design principles, such as clear articulation and alignment of learning objectives with course components. Many syllabi included a table showing this alignment. This practice also helped I-Course faculty critically reflect on their assessments and policies and make changes based on this reflection. This focus resulted in the elimination of some practices that were unrelated to the course learning objectives. For example, Professor Lens reflected,

> *"I think always focusing on the learning objectives and then thinking of everything else as supplementary… is the core of [neurodiverse] teaching. Because I had… a really strong focus on all these other things… like, Oh, it's important that they know how to take an exam. And I don't really know if that's… what we are supposed to teach students…"*

Accessibility

Several practices were adopted to ensure accessibility in I-Courses, including accessible, electronic or alternative format textbooks, clear instructions and expectations about grading, posting course resources online, captioned videos, and virtual labs. All course materials are provided in accessible formats, including class notes alongside slides, digital textbooks, and videos with captions, to accommodate diverse learning preferences. Accessibility technologies, like speech-to-text tools and note-taking assistance are often listen in course syllabi. In problem-solving courses, such as Mechanics of Materials, smart tablets or personal iPads connected to projectors are used, and instructors save their class notes as PDF files for student review. Furthermore, some instructors have adopted smartbooks and platforms like McGraw-Hill Connect for courses, which allow students to check their work before submission and receive instant feedback. Additionally, videos used in the course include 99% accurate closed captions, in compliance with ADA standards, with former undergraduate students hired to assist with monitoring and finalizing captions. Classrooms are equipped with Kaltura video recording capabilities, and recordings are shared via Blackboard, though a decline in attendance led instructors to incorporate graded active learning strategies to maintain engagement.

Active Learning

In I-Courses, faculty incorporated a variety of active learning strategies to enhance student engagement and understanding. These include polling via iClickers, Slido, or Padlet, flipped classrooms, group discussions, think-pair-share, in-class problem-solving, case studies, and role-play. Polling applications such as iClicker and Slido allowed students to participate anonymously via QR codes or personal devices, encouraging broader engagement. Professor Gauge pointed

out that *"it created a natural, instant feedback to me during the lecture where I then could also adapt the lecture in terms of pace, content, or [if] I needed to repeat something or not."*

Faculty also integrated in-class group work, where students collaborate in teams or work individually to solve problems with real-time feedback from instructors and teaching assistants. Professor Twist reflected that,

> *"As part of Include, I started to incorporate more active learning components in class and what that forced me to do is to slow down and see how what I was talking about was received on the student side, which I should have done long ago."*

Professor Spark mentioned using physical models, such as using pool noodles to simulate structural behaviors, to illustrate engineering concepts like stress-strain relationships and element capacity under loads, saying,

> *"interacting with my students who were receiving accommodation… I was observing their creativity and their engagement when they were dealing with hands-on projects and… the excitement… that they created for the class."*

Personalization

I-Course instructors offered students the opportunity to make choices to personalize their learning experience. For example, several faculty allowed students to choose assessment formats and approaches that aligned with their strengths, such as written essays, oral presentations, or multimedia projects. Two instructors implemented strength-based projects, where students selected topics aligned with their interests or strengths [39]. Professor Lens reflected on how the ability to choose between assessment formats appeared to benefit all students, saying,

> *"There wasn't one option, better for everyone… if the project option was better for everyone, then we should all go with project-based assessment, right? But it wasn't. And there were still students who were doing much better and preferring to do the exams and have much more weight placed on the exams*."

Professor Gauge offered students the option to choose between individual and group work as a way to accommodate different levels of sociability, saying, *"Some students, they want to be quiet or some students are more shy… or… maybe tend to be more introvert than extrovert."* One instructor even integrated stretch breaks during classes as a simple yet effective way to improve focus and productivity, giving students who have a higher need for movement a chance to personalize the class experience.

Course Policies

A range of supportive academic policies were implemented to provide flexibility and support students' mental health. Some allowed students to request homework and assignment extensions without needing to provide an explanation. Others provided makeup tests, multiple attempts and opportunities for revision, allowing students to resubmit assignments to improve their grades.

For example, Professor Lens had *"an optional final exam that can be used to make up for any exam grade during the semester,"* giving one final opportunity for students to replace their lowest midterm score, while reducing anxiety and stress. In some courses, multiple grading tracks enabled students to select the grading or assessment plan that best aligned with their strengths. Professor Gauge said, *"the other major change was offering a track A and track B, where on track A was regular homeworks and the mid-term and the final exam and track B was regular homeworks and a course project."* Professor Lens, who also implemented multiple grading tracks, explained the reasoning behind this design, saying,

> *"I implemented… two grading scheme options where one was a little more heavily focused on exams and then the other one was a little more heavily focused on the project. I was making space for students who maybe struggle with exams to not have to feel a lot of pressure around performing really well during a short, limited amount of time. But I also realized that it works the other way around because there are students who really struggle with doing a project distributed over 3-4 weeks and they have one deadline."*

Table 6. Summary of teaching and learning interventions

Intervention	Notes	N (%)
Instructional Design		
Alignment of learning objectives with course components	Use planning worksheet provided by teaching and learning center	9 (100%)
Articulation of Learning Objectives	In syllabus	9 (100%)
Accessibility		
Smart, electronic, or alternative formats of textbooks	Accessible, adaptive	3 (33%)
Captioned videos and accessible materials (documents, PDFs)	Support for captioning provided by project	5 (56%)
Clear instructions	Written instructions, clear deliverable, roles for group work	3 (33%)
Posting resources online	Classroom video recordings, lecture slides, problem solutions	6 (67%)
Virtual labs	Primarily offered during Covid-19 pandemic, online learning modality	1 (11%)
Active Learning		
In-class problem-solving	Flipped course	2 (22%)
Polling	iClickers, Slido, WebEx, raising hands	6 (67%)
Physical/3D models	Created by both faculty and students	1 (11%)
Group work	Think-pair-share, role-play, discussions	6 (67%)

Case studies		1 (11%)
Personalization		
Choice of format for assessments	Exam or project, written exam or oral exam	5 (55%)
Strength-based project	Optional project incorporating choice of topic and/or project track	2 (22%)
Student Choice	Modes of participation, grading schemes, individual vs. group work, topics, optional final exam	7 (78%)
Metacognition Activities	Opportunities for individual critical reflections	3 (33%)
Stretch breaks		1 (11%)
Course Policies		
Lower-stakes assessments	Homework revisions, makeup tests, test retakes, replace low exam grade with oral exam grade, replace midterm grade with optional final exam grade, dropping lowest grade; frequent, smaller assessments, bonus points	7 (78%)
Extensions on work	Homework extensions, no-questions asked extensions	2 (22%)
Nontraditional grading scheme	Choice of grading tracks/schemes, ungrading	3 (33 %)

Communication and Supports

This section highlights 3 categories related to communication and supports: feedback, building connections, and personalized support.

Feedback

To collect and integrate student feedback throughout the semester, instructors employed several mechanisms. These included polling platforms such as Slido, iClicker, or Padlet, allowing students to give electronic feedback via their mobile devices, while anonymous surveys on platforms like Blackboard or Qualtrics were used to gather insights on course elements. Professor Lens mentioned using mid-semester student feedback to reflect on student preferences on the course format, saying,

> *"I was looking at some of my course feedback midsemester… and I realized that there are a lot of students who really like hybrid learning with online videos, but there's also an about equal number of students who are saying, 'I prefer that all the lectures were in-person and I can't learn very well with videos.'"*

Some instructors then summarized student feedback, shares aggregated data with students, and presented actionable plans to address suggestions. Professor Hatch said,

> *"I revamped the evaluation that I was using and one of the things I did, is I show the students the results of it… Show them the results, the feedback that I got and then also the things that I'm going to change to try and address their concerns."*

In some cases, the feedback loop went beyond simply providing input on course formats, helping faculty build empathy for student experiences. Professor Twist explained,

> *"…as part of Include, in the beginning, in the middle, and in the end of the semester, I did surveys for students to tell me about their evaluation of their own status and their experience and what challenges that they are dealing with in terms of neurodiversity. So, what I learned through reading that survey is mind blowing… that was my first experience to realize and understand that students are vulnerable… and that motivated me to look at how I administer exams and what are important things that I really want students to show…"*

Building Connections

Faculty fostered personal connections with students by providing at least one opportunity per semester for interaction beyond traditional instruction. These opportunities may include activities such as FlipGrid reflections, in-class games or discussions, or group projects with a social component. For example, some faculty used playful interpretations of iClickers, providing socially oriented questions or games. Professor Gauge mentioned that polling on informal topics such as how students were feeling or what they ate that day allowed him to *"connect with them easily."* Professor Craft also mentioned that discussion boards implemented during the Covid-19 pandemic were phased out once it was apparent that optional activities were not prioritized by students. He said,

> *"I mean, everyone was stressed out, right? And I think the situation with the neurodiverse students, it was probably even worse, right? I mean, just sitting at their home in a corner with a tablet or a laptop. So, I thought I would start a discussion board on Husky CT so that the students can socialize a little bit… But with time during the semester… the motivation to write on the board waned. So, I didn't have as much response toward the end… So, that I discontinued altogether."*

Personalized Support

Some instructors encouraged students to consider connecting with campus resources they report challenges such as difficulty concentrating, inadequate exam time, or significant test anxiety. Professor Spark describes sharing resources in one-on-one interactions with students, saying,

> *"Sometimes you see that the students do not know about resources. So, reminding, and just sharing, it really helps that finally they reach out. And that's actually one main issue that many undergrads, they either they feel shy to reach out to TAs or instructors. They*

don't come up to office hours. Rarely. But when they come, I try to be welcoming and encouraging them. 'Oh, that's awesome. Thanks for coming to office hours.' Not judging them but more getting excited and encouraged."

Additionally, in some courses, faculty implement specific supports such as weekly reminders and the maintenance of a dynamic calendar system where students access a live, executive-function-supporting calendar, such as a Google Doc, that is updated weekly with the actual schedule, changes, and deadlines. Professor Spark further explained adopting a coaching approach for students, saying,

"… after participating in Include, I have a better structure with reminding my students with upcoming deadlines and assignments and assessments and keeping them on track… I remind them [at the] beginning of the class. Then, I send an announcement a couple of times… making sure that they have me as a coach. 'This deadline is coming.'"

Table 7. Summary of communication and supports interventions

Intervention	Notes	N (%)
Feedback		
Gathering student feedback about class	Mid-semester surveys, anonymous feedback at office door, welcoming face-to-face feedback	9 (100%)
Providing feedback to students about their performance	Timely feedback, technology (e-book) for instant feedback on student work, enhancing feedback through active TA engagement, narrative and numerical feedback, peer feedback	8 (89%)
Building Connections		
Office hours (flexible)	Virtual or in-person, pre-determined, by appointment, late office hours, "student hours"	9 (100%)
Personal and social connections	Discussion boards, polling games, survey responses	4 (40%)
Personalized Supports		
Sharing campus resources	Sharing resources in syllabus, verbally mentioning resources in class, one-on-one discussions with students	9 (100%)
Use of live/dynamic course schedule or calendar	Shared Google doc, calendar, or other shared document	3 (33%)
Weekly reminders	Via email or LMS announcements	3 (33%)
Review sessions	Provided by TAs or UTAs	2 (22%)

Challenges to Sustainability of Neuroinclusive Practices

Faculty reflections on the process of implementing neuroinclusive teaching practices in I-Courses has revealed several challenges that impact their sustainability. Issues such as overwhelming choices, labor-intensive practices, and student preferences have sometimes limited the long-term feasibility of these approaches. Brief summaries of these challenges are presented below, along with quotes from the instructors who described them.

Too Much Flexibility

One major challenge identified was the overwhelming number of options and flexibility offered to students, which sometimes led to confusion, anxiety, or stress. For example, when multiple assessment options were provided, Professor Lens observed, *"Students were given too many options. Some of them feel like, How do I know whether I'm gonna do better in taking the exam or doing the design project?"* This led the instructor to streamline the process by making the design project mandatory rather than optional. Similarly, flexible deadlines, while intended to support students with ADHD, were not always effective. Professor Field reflected, *"Giving somebody with ADHD flexibility in due dates didn't always seem to work... I think it wasn't helpful for some people."* This highlighted the need to balance flexibility with some students' need to power their motivation with stricter deadlines.

Time and Labor

Grading and creative assignments presented additional questions for some faculty. Despite the intense time commitment required by professors, strength-based projects, sometimes lacked technical depth and became repetitive. Professor Spark shared, *"I ended up receiving redundant projects. Minimum work. Repeat, repeat of stuff... That's not what I wanted. I wanted them to explore and look at the real world."* Managing these projects in large classes was quite labor-intensive, as Professor Muse noted, *"I graded 160 projects in one semester with my TAs. After that, I phased out the project options because it was not manageable anymore."* Alternate grading schemes and student feedback also placed considerable demands on instructors. Professor Field noted, *"Students have to be trained to give good feedback... I'll have to try something different next year."* Similarly, using tools like clickers were perceived as engaging in some courses, but took time away from other activities. Professor Gauge explained, *"Clicker questions take some time away from the lecture."*

Student Preferences

Feedback loops revealed that students held mixed opinions about learning formats. Professor Lens remarked, *"There are a lot of students who really like the hybrid learning with online videos, but there's also an equal number who say, 'I prefer that all the lectures were in-person.'"* These diverging preferences may reflect broader cultural and social shifts as students have emerged from the largely virtual world of education during the COVID-19 pandemic. Maintaining student participation in optional activities, such as discussion boards, proved challenging as well. Professor Craft reflected, *"At the very beginning, more than 50% of students took part in the introduction module, but as the semester progressed, involvement dropped off. I*

wish they participated more." The lack of grading incentives contributed to the decline, despite efforts to foster a sense of community through these platforms. While initially intended to engage students, polling tools were sometimes perceived as a source of distraction and inefficiency. Professor Twist says, *"Instead of using iClickers, I put the question on the screen and ask students to raise their hand... Students actually like this more interactive way of doing things in-person."*

Conclusion

In response to our first research question (What practices were adopted in redesigned neuroinclusive courses?), we found that most faculty in this project implemented a range of interventions, such as inclusion statements and strength-based language, hands-on learning, creative projects, flexible grading policies, and low-stakes assessments, to create a more inclusive learning environment that they perceived as a benefit to all students. Regarding our the sustainability of these practices (our second research question), many of these practices persisted – especially inclusion statements, active learning, and flexible policies – while others were discontinued due to time demands or mixed reception of the changes by students. These strategies emphasized flexibility in learning and assessment, but they also revealed challenges in balancing innovation with sustainability. Some interventions were too labor-intensive or led to unintended consequences, such as overwhelming choices or reduced participation in optional activities. This study highlights both the potential and limitations of neuroinclusive course redesign, accentuating the need for sustainable approaches that maintain accessibility without overburdening instructors or students. Interventions that significantly increased instructor workload (such as managing multiple assessment options or projects requiring intense guidance for successful completion) tended to fade over time. The shift toward strength-based language and a focus on creating a welcoming and supportive culture transformed faculty perceptions of and enhanced faculty relationships with neurodiverse students without requiring significant additional workload. These findings point toward the key role of instructor mindset in building more neuroinclusive environments. Future efforts may explore the role of AI technology in providing personalized learning tools and supporting neuroinclusive practices more efficiently so that educators can maintain these practices without burnout. Longitudinal studies are needed to assess their long-term impact on student success and retention in engineering programs.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. 1920761. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

[1] J. A. Gasiewski *et al*, "From Gatekeeping to Engagement: A Multicontextual, Mixed Method Study of Student Academic Engagement in Introductory STEM Courses," *Res High Educ,* vol. 53, *(2),* pp. 229–261, 2012. . DOI: 10.1007/s11162-011-9247-y.

[2] M. Chrysochoou, A. E. Zaghi and C. M. Syharat, "Reframing neurodiversity in engineering education," *Frontiers in Education (Lausanne),* vol. 7, 2022. . DOI: 10.3389/feduc.2022.995865.

[3] A. E. Zaghi *et al*, "Unique potential and challenges of students with ADHD in engineering programs," in *2016 ASEE Annual Conference & Exposition,* 2016, pp. 1–15.

[4] N. Doyle, "Neurodiversity at work: a biopsychosocial model and the impact on working adults," *British Medical Bulletin,* vol. 135, *(1),* pp. 108–125, 2020. Available: https://doi.org/10.1093/bmb/ldaa021. DOI: 10.1093/bmb/ldaa021.

[5] X. Wei *et al*, "Postsecondary Pathways and Persistence for STEM Versus Non-STEM Majors: Among College Students with an Autism Spectrum Disorder," *J. Autism Dev. Disord.,* vol. 44, *(5),* pp. 1159–1167, 2013. . DOI: 10.1007/s10803-013-1978-5.

[6] R. L. Sparks, J. Javorsky and L. Philips, "College Students Classified with ADHD and the Foreign Language Requirement," vol. 37, *(2),* pp. 169–178, 2003. .

[7] N. Honken and P. A. S. Ralston, "Freshman Engineering Retention: A Holistic Look," vol. 14, *(2),* pp. 29–37, 2013. .

[8] N. W. Moon *et al*, *Accommodating Students with Disabilities in Science, Technology, Engineering, and Mathematics (STEM): Findings from Research and Practice for Middle Grades through University Education.* Atlanta, GA: SciTrain: Science and Math for All, 2012.

[9] National Academies of Sciences, Engineering, and Medicine *et al*, *Graduate STEM Education for the 21st Century.* Washington, D.C: National Academies Press, 2018.

[10] National Center for Science and Engineering Statistics, "Diversity and STEM: Women, minorities, and persons with disabilities 2023," National Science Foundation, 2023Available: https://ncses.nsf.gov/pubs/nsf23315.

[11] A. Hain, A. E. Zaghi and C. L. Taylor, "Board 164: Promoting neurodiversity in engineering through undergraduate research opportunities for students with ADHD," in *ASEE Annual Conference and Exposition,* 2018, pp. 1– 10.

[12] C. M. Syharat, A. Hain and A. E. Zaghi, "Diversifying the engineering pipeline through early engagement of neurodiverse learners," in *2020 ASEE Annual Conference & Exposition,* 2020, .

[13] C. L. Taylor *et al*, "Characteristics of ADHD Related to Executive Function: Differential Predictions for Creativity-Related Traits," *The Journal of Creative Behavior,* vol. 54, *(2),* pp. 350–362, 2020. . DOI: 10.1002/jocb.370.

[14] C. L. Taylor and A. E. Zaghi, "The Nuanced Relationship Between Creative Cognition and the Interaction Between Executive Functioning and Intelligence," *The Journal of Creative*

Behavior, vol. 55, *(3),* pp. 857–874, 2021. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/jocb.493. DOI: 10.1002/jocb.493.

[15] H. A. White and P. Shah, "Creative style and achievement in adults with attention-deficit/hyperactivity disorder," vol. 50, *(5),* pp. 673, 2011. Available: http://www.sciencedirect.com/science/article/pii/S019188691000601X.

[16] K. E. Hupfeld, T. R. Abagis and P. Shah, "Living "in the zone": hyperfocus in Adult ADHD," vol. 11, pp. 191–208, 2018. .

[17] C. L. Taylor *et al*, "Divergent thinking and academic performance of students with attention deficit hyperactivity disorder characteristics in engineering," *Journal of Engineering Education (Washington, D.C.),* vol. 109, *(2),* pp. 213–229, 2020. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/jee.20310. DOI: 10.1002/jee.20310.

[18] L. Mottron, "Changing perceptions: The power of autism," vol. 479, *(7371),* pp. 33–35, 2011. .

[19] B. Crespi, "Pattern Unifies Autism," *Front. Psychiatry,* vol. 12, 2021.

[20] E. A. Attree, M. J. Turner and N. Cowell, "A Virtual Reality Test Identifies the Visuospatial Strengths of Adolescents with Dyslexia," vol. 12, *(2),* pp. 163–168, 2009. . DOI: 10.1089/cpb.2008.0204.

[21] G. Rappolt-Schlichtmann, A. R. Boucher and M. Evans, "From Deficit Remediation to Capacity Building: Learning to Enable Rather Than Disable Students With Dyslexia," *Language, Speech & Hearing Services in Schools; Lang Speech Hear Serv Sch,* vol. 49, *(4),* pp. 864–874, 2018. . DOI: 10.1044/2018_LSHSS-DYSLC-18-0031.

[22] M. M. Elsherif *et al*, "Bridging neurodiversity and open scholarship: How shared values can guide best practices for research integrity, social justice, and principled education. ," *MetaArXiv,* 2022. .

[23] C. Cortiella and S. H. Horowitz, "The state of learning disabilities: Facts, trends and emerging issues," New York, 2014.

[24] K. E. Zuckerman *et al*, "Latino Parents' Perspectives on Barriers to Autism Diagnosis," *Academic Pediatrics,* vol. 14, *(3),* pp. 301–308, 2014. Available: https://www-sciencedirect-com.ezproxy.lib.uconn.edu/science/article/pii/S1876285913004245. DOI: 10.1016/j.acap.2013.12.004.

[25] M. D. Moody, "“Us Against Them”: Schools, Families, and the Diagnosis of ADHD Among Black Children," *J. Racial and Ethnic Health Disparities,* vol. 4, *(5),* pp. 949–956, 2016. . DOI: 10.1007/s40615-016-0298-9.

[26] L. M. Haack *et al*, "Influences to ADHD Problem Recognition: Mixed-Method Investigation and Recommendations to Reduce Disparities for Latino Youth," *Adm. Policy Ment. Health,* vol. 45, *(6),* pp. 958–977, 2018. . DOI: 10.1007/s10488-018-0877-7.

[27] J. A. Chen *et al*, "Psychiatric Symptoms and Diagnoses Among U.S. College Students: A Comparison by Race and Ethnicity," *PS,* vol. 70, *(6),* pp. 442–449, 2019. Available: https://ps.psychiatryonline.org/doi/10.1176/appi.ps.201800388. DOI: 10.1176/appi.ps.201800388.

[28] S. Shmulsky, K. Gobbo and S. Vitt, "Culturally Relevant Pedagogy for Neurodiversity," *Community College Journal of Research and Practice,* vol. ahead-of-print, *(-),* pp. 1–5, 2021. . DOI: 10.1080/10668926.2021.1972362.

[29] G. Bettencourt, E. Kimball and R. S. Wells, "Disability in Postsecondary STEM Learning Environments: What Faculty Focus Groups Reveal About Definitions and Obstacles to Effective Support," *Journal of Postsecondary Education and Disability,* vol. 31, *(4),* pp. 383–396, 2018. .

[30] E. d. S. Cardoso *et al*, "Experiences of Minority College Students with Disabilities in STEM," *Journal of Postsecondary Education and Disability,* vol. 29, *(4),* pp. 375–388, 2016. .

[31] S. L. Haft, C. Greiner de Magalhães and F. Hoeft, "A Systematic Review of the Consequences of Stigma and Stereotype Threat for Individuals With Specific Learning Disabilities," *J. Learn. Disabil.,* vol. 56, *(3),* pp. 193–209, 2023. . DOI: 10.1177/00222194221087383.

[32] C. Kreider *et al*, "A multifaceted approach to supporting STEM/SBE students with learning disabilities: Highlights of engineering student participants," *Qscience Proceedings,* vol. 2015, *(4),* 2015. . DOI: 10.5339/qproc.2015.elc2014.70.

[33] L. Clouder *et al*, "Neurodiversity in higher education; a narrative synthesis," *Higher Education,* vol. 80, *(4),* pp. 757–778, 2020. Available: https://www-jstor-org.ezproxy.lib.uconn.edu/stable/48736443.

[34] R. A. Miller and M. Downey, "Examining the STEM Climate for Queer Students with Disabilities," *Journal of Postsecondary Education and Disability,* vol. 33, *(2),* pp. 169–181, 2020. .

[35] Y. P. Weatherton and R. D. Mayes, "Barriers to persistence for engineering students with disabilities," in *ASEE Annual Conference & Exposition,* 2017, .

[36] S. Haft and F. Hoeft, "A Meta-Analytic Review of the Consequences of Stigma and Stereotype Threat for Individuals with Specific Learning Disabilities," unpublished, private communication, (Preprint).

[37] M. Chrysochoou *et al*, "Redesigning engineering education for neurodiversity: New standards for inclusive courses," in *2021 ASEE Annual Conference and Exposition,* 2021, .

[38] CAST, "Universal Design for Learning Guidelines version 2.2," 2018.

[39] S. Motaref, "Strength-based projects in the mechanics of materials course to enhance inclusivity and engagement," in *2022 ASEE Annual Conference and Exposition,* 2022, .