Engineering Instructors' Constructions of the Universality or Individuality of Neurodiversity

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Neurodiversity is an umbrella term highlighting an important aspect of human diversity. Specifically, this term refers to the wide range of neurological variations present in human populations. Often, engineering courses are designed with traditional teaching methods that aim to meet the learning needs of "average" or "typical" engineering students. However, research shows that students vary in terms of their interests, cognitive skills, and needs; neurodivergent students in particular are often disengaged, and their learning compromised in traditional engineering settings. To support engineering instructors in implementing inclusive instructional strategies that engage and empower neurodivergent students (e.g., Universal Design-aligned strategies), we hosted a multi-year professional development series for a group of faculty members engaging in a course redesign process as part of a NSF Revolutionizing Engineering Departments grant. At the end of each project year, we conducted hour-long, semi-structured interviews with participating engineering instructors about the changes they implemented in their instruction to promote the inclusion of neurodivergent students, their beliefs about neurodiversity and accommodations, and the impact of the professional development series. In this study, we analyzed five of these interviews drawing upon discursive psychology to investigate how language was used to construct and support the instructors' understanding of neurodiversity and accommodations. We found a question that instructors are grappling with: the universality or individuality of neurodiversity (i.e., is everyone included under the neurodiversity umbrella or only a subset of students). This question has implications for faculty professional development related to neurodiversity, for the development of inclusive instructional practices, and for the role of instructors in supporting a neurodiverse student body. Specifically, viewing neurodiversity as universal can lead instructors to consider course-wide inclusive practices while focusing on neurodiversity (neurodivergence) within individuals can lead instructors to consider the needs and experiences of individuals.

I. Background

This study is part of a NSF Revolutionizing Engineering Departments project that seeks to empower neurodivergent students to persist and thrive in engineering education, by taking a strengths-based approach (i.e., placing focus on the individuals' cognitive skills instead of focusing on mitigating their perceived weaknesses) towards neurodiversity in academic and

instructional practices across a Department of Civil and Environmental Engineering in a large, research intensive, public institution. To promote instructors' consideration of neurodiversity and the integration of supportive practices in their teaching, the project created a year-long Faculty Learning Community called the I-team, which involved professional development opportunities for instructors focused on redesigning their courses with respect to neurodiversity and engineering education best practices. After completion of the year-long process, we interviewed instructors about their experiences in the professional development and about their attitudes and beliefs about neurodiversity. The purpose of this study is to investigate participating instructors' specific ideas about neurodiversity in relation to instruction via analysis of the interview transcripts and the language used by participants.

A. Neurodiversity in STEM

Neurodiversity is an umbrella term coined by Judy Singer [1], who conceptualized neurological variations in human populations as a key important aspect of diversity. A wide range of neurological variations fall under the neurodiversity umbrella, including, but not limited to, such as autism (ASD), attention deficit hyperactivity disorder (ADHD), and dyslexia. Often, engineering courses are characterized by traditional modes of instruction and assessment that encourage standardized approaches to engineering problems [2] [3]. Neurodiversity advocates value the inherent differences between people and emphasize the fact that there is no correct way of thinking or of experiencing the world, and that these differences are not a deficit [4] [5]. There are a range of approaches toward understanding neurodiversity; while some view their neurodivergence as disabling when the environment does not support their access and participation, others emphasize neurodiversity as an aspect of diversity akin to gender or race/ethnicity, and some view their neurodivergence as an integral part of their identity [6]. In the first view, accommodations are viewed as a means of providing access and leveling the playing field for neurodivergent people. Both views are in sharp contrast with the medical model that pathologizes neurodiversity and views neurodivergent individuals as deficient and seeks interventions that aim to "fix" or "mitigate" individuals' deficiencies. In this deficit-based view, accommodations are viewed as a mechanism to "compensate" for deficits.

Prior research about neurodiversity found that it might be associated with creativity, innovation, and risk-taking which are critical skills for 21st century engineers [7]-[9]. However, neurodivergent individuals are severely underrepresented in engineering programs. In fact, one study of individuals diagnosed with attention deficit/hyperactivity disorder (ADHD; N = 68) found that only 3% of students across the university were studying engineering [10]. Syharat, Hain, and Zaghi [11] posit that this low representation is because neurodivergent students are minoritized by the rigid structures and barriers created by traditional education systems. Traditionally, higher education courses are designed for "average" or "typical" students and thus are not designed to support the variety of learners' needs, abilities, and interests [12]. This significantly impedes the sense of belonging of non-traditional learners and those whose

preferred communication mode is other than reading and writing. The purpose of this project was to support engineering instructors in redesigning their courses to support and engage a broader range of neurological and cognitive functioning within students to support and promote participation of non-traditional thinkers and problem solvers in the engineering fields. The purpose of this study was to investigate instructors' conceptions of neurodiversity to provide insight on the effects of the professional development on instructors. Additionally, it follows that instructors' views about neurodiversity affect the ways in which they support (or do not support) neurodivergent students in their courses.

B. Instructors' Mindset Toward Neurodiversity

Multiple studies have investigated instructors' views about and their preparedness to teach students who vary in terms of their needs, abilities, and interests. These studies show that faculty lack awareness of the legal requirements related to accommodations [13]-[15], lack knowledge of inclusive pedagogies [16], and that they want more training related to accessibility [17]. STEM faculty have also been shown to be less amenable to the use of accommodations in their courses and to hold more negative beliefs than their counterparts in other academic disciplines [18]-[20]. According to Svyantek [21], "While two and a half decades have passed with the [Americans with Disabilities Act] (ADA) in place to mandate "reasonable accommodations" and accessibility in terms of employment, education, and transportation, significant structural and social barriers to access still exist."

Much of the literature related to discourse around neurodiversity focuses on language used by neurodivergent individuals and their advocates/allies in online forums [22] [23]. In the higher education setting, Lester, Dostal, and Gabriel [24], found that the public-facing websites of university-based Offices of Disability Services ascribed a range of meanings to disability as a construct, which had implications for students' access to services. Considering neurodiversity as an umbrella term for the full range of human diversity, Lester and colleagues discuss how some discourses position individual students' rights to accommodations in opposition to the integrity of institutional programs, others position disability laws as in opposition to the university's interests, and others construct disability services as a space for nurturing diversity and inclusion in alignment with the university's interests [25]. These discourses related to disability echo across the literature as it is defined and constructed variably as legally bound, academically challenging, or in alignment with diversity as a value [25]. These varied constructions of disability in higher education settings are central to understanding current framing of neurodiversity in education settings, which Acevedo and Nusbaum [26] argue "effectively disrupt the systematic categorization of alternative neurological and cognitive embodiment(s)"and "offers an emancipatory lens for representing and embodying neurological differences beyond traditional special education's deficit-based discourses and practices."

C. INCLUDE Project

The INCLUDE project funded by the Revolutionizing Engineering Departments program of the National Science Foundation has been established to transform department-wide practices and create an inclusive learning environment that empowers the diversity of learners present in institutions of higher education. This project aims to develop and refine a range of interventions targeted towards multiple aspects of academic life, from recruitment to career development. The INCLUDE team draws on Chapman's [27] ecological model of mental functioning which emphasizes the ways in which individual neurological variations contribute to human ecosystems and enhance persistence and adaptation of societies, and Taylor et al.'s [26] theory of complementary cognition, which suggests that neurological diversity within populations enhance adaptation through the use of complementary search strategies that allow for both exploration of unknown resources and exploitation of known resources. In this model, neurodiversity is a fundamental aspect of human diversity that enables groups and societies to adapt and thrive by contributing different ways of thinking and problem-solving to survival [28]. In the context of engineering education, this translates to an increased ability of cognitive diverse teams to contribute to problem-solving and innovation in complex engineering problems [29].

A strength-based approach that moves away from deficit-based language and academic accommodations is the basis for the redesign of courses and the training of faculty to implement the redesign. Instructors in the Civil and Environmental Engineering volunteered to participate in professional development related to the strength-based approach to neurodiversity and to engage with a yearlong Professional Learning Community, which meets weekly to discuss the design and implementation of Universal Design for Learning (UDL) principles within their courses, and to develop and refine a set of standards for inclusive instruction in engineering described as the I-Standards (see [29] [30]). Data analyzed in this paper are drawn from the first year of the project and therefore focus specifically on discourse related to the first iteration of professional development and professional learning with respect to language around neurodiversity. Both the content and format of each have been continuously refined over the multi-year project.

D. Research Questions

As Spingola [31] notes "the low representation of engineering research related to mental, emotional, and learning disabilities within higher education denotes a gap in data collected about and with this particular subset of the disabled population." In this study we sought to address this gap in the research with the following research question: How do faculty members in a Civil and Environmental Engineering (CEE) department describe neurodiversity across a year of inclusion-focused PD experiences?

II. Methods

A. Participants

We recruited participants who participated in the professional development opportunity. Across the 6 initial participants who engaged in the professional development from the first year of the study, we recruited 3 participants to participate in one or two interviews about their conceptions of neurodiversity and their experiences in the professional development. Table 1 lists the participants and their role within the university.

Table 1: Interview Participant Information

Pseudonym	**Date(s) of Interview**	**Role**
Participant 1	Fall 2020 Spring 2021	Associate-level teaching faculty
Participant 2	Fall 2020- Spring 2021	Assistant-level teaching faculty
Participant 3	Fall 2020	Tenured faculty

The participants completed one or two one-hour semi-structured interviews aimed at investigating participating instructors' experiences within the professional development, the course(s) that they redesigned to utilize universal design principles, and their views about neurodiversity and accommodations.. We focused our analysis on questions 1 (How would you describe neurodiversity?) and 2 (How would you describe universal design for learning?) from the fall interview protocol and question 1 (Has your understanding of neurodiversity changed? a) Do you find yourself having more/open conversations with your students about neurodiversity? b) Have you noticed more students identifying as neurodivergent/seeking accommodations?) from the spring interview protocol. We analyzed these questions because they focused on neurodiversity and the participants' conceptions of neurodiversity. These questions represent three out of the ten interview questions.

C. Positionality

This paper was written by a team of neurodivergent individuals and their allies. Our motivation and approach to this work is shaped by the personal experiences of the neurodivergent authors and by our experiences working with a range of neurodivergent students within STEM teaching and research contexts. We also believe it is important to acknowledge that while our team does represent diverse perspectives in terms of gender, cultural background, and other social identities, our perspectives are informed, and in some ways limited, by our experiences as white individuals in the United States.

C. Analysis

Our analysis is informed by Discursive Psychology (DP) [32] [33] which conceptualizes psychological constructs, including neurodiversity, as socially-constructed and up for negotiation and active construction within talk and social interaction. We therefore analyze how language is used to construct particular versions of neurodiversity, and consider what these versions might mean for teaching and learning in undergraduate engineering programs. Within DP, analysts consider micro-level features of conversation – including turn-taking, word choice, case formulations (c.f. [34]) - alongside rhetorical and interactional functions such as positioning [35] management of stake and interest [36], and the construction of interpretative repertoires [37].

Our four-step analytic process focused on transcripts of interviews from the Fall and Spring semesters of our first year of implementation. The first step (1) was to listen and relisten to the interviews, alongside the transcripts, in order to familiarize ourselves with the data and check the accuracy of computer-generated transcriptions. The next step (2) was for two researchers (EMS and REG) to identify extracts of each transcript with the concept of neurodiversity was described, defined, or discussed in order to (3) engage in a closer, line-by-line analysis of how language is used to work up specific versions of neurodiversity in talk across participants and over time, considering the analytic tools of DP. Close analysis revealed several patterns that connect to the participants' constructions of neurodiversity. (4) As we worked separately and together to develop these themes, we discussed examples and looked across the data to confirm or disconfirm our findings.

III. Findings

A. Describing Neurodiversity

In the interviews, participants responded to the question: How would you describe neurodiversity? Across participants and timepoints, the participants' conceptions differed. In particular, there was a frequent conflation of terms defined and deployed distinctly by disability scholars and activists (c.f. [38]), including "neurodiversity, neurodiverse, neurodivergent." We understand these conflations contrast with existing definitions and distinctions as evidence of participants grappling with terminology that is new to them, often in a second or other language. In the Fall 2020 interviews, Participant 1 stated "*neurodiversity is just diversity in neural function, right? And then I think it is [a] natural term, everyone's different, right? And then everyone's talent is different. And everyone's neural functions [are] different. So. And also, before participating [in] this project, I also think that learning styles are different for each person, and that is not so much different than your diversity. So it's just one type - one type of diversity and I believe everyone's different. So I think using UDL is very helpful for everyone. So, I don't know if I answered your question, but neurodiversity is just one type of diversity. And then I accept that. Yep. That is, yep. always a necessary thing to consider*."

The phrase “is just” is a hedge (e.g., “neurodiversity is just diversity”) used several times to minimize the case of neurodiversity as a construct that indicates difference. Instead, it is described as “natural” and “just one type of diversity.” The comparison to learning styles is used to further universalize the phenomenon of neurodiversity as something that applies to everybody and is therefore, “not so much different” because “everyone is different.” The pronoun “everyone” is mentioned five times, to universalize the type of difference described in neurodiversity. This move to universalize neurodiversity is also apparent in the drawing a similarity to the known construct of “learning styles,” which is understood as applying to everyone. Taken together, these moves work to construct a version of neurodiversity that is natural, universal, and no different from commonly recognized existing ideas.

In the Spring 2021 interview, Participant 2 highlighted that neurodiversity is not a disability but instead a different ability, stating “*I am totally open to accommodate our neurodiversity students.*[1] *And to be honest with you, I don't see it as disability, I see that different ability. Yeah, so this is my, my comprehension and something that I truly believe. So I don't see them, like different than my other students, or I know that they are as strong in other areas, and I will be more than happy to accommodate. But again, what I like to see is that effort, they're still making the effort to learn and be successful. So I don't want to make any difference between regular students and neurodiverse students, I like to see that, you know, hard effort to learn the material. But if they need accommodation, for example, time of submission, or if they need like, extra help, or whatever, I will be more than happy to provide. Right?*”

The statement above starts and ends with an extreme case formulation related to providing accommodations, “totally open,” and “more than happy,” both of which work to emphasize willingness to accommodate neurodiversity among students [32]. This is immediately followed by the same minimizing or universalizing theme demonstrated by the first participant above. Participant 2 reports that they “don’t see it as a disability,” that they “don’t see them like different” and they “don’t want to make any difference between regular or neurodiverse students.” This suggests the awareness that a difference is or could be made, alongside a repetitive reference to their decision not to make such a distinction.

The distinction that is made between “neurodiverse” and “regular” students is that they “like to see” students “making an effort.” This distinction indicates that behaviors of students, or choices made by students, are what matter, and that their performance or success in their eyes is within their control. This raises questions about how effort is portrayed and perceived in such contexts. If the instructor “likes to see” effort and will then be “more than happy” to accommodate

[1] Earlier in the project, the project leadership decided to use the term “neurodiverse” rather than neurodivergent, despite its grammatical incongruence, as it emphasizes cognitive diversity, rather than divergence from a norm. To keep up-to-date with recent activism and scholarship regarding neurodiversity, we have updated the language used throughout the paper, excluding direct quotes from participants, to match the language used in [38].

learners who put forth effort, the ability to demonstrate effort to an instructor is as, if not more, important than disability status. This points to a socially-constructed version of student that is worthy of accommodation by positioning students as having the responsibility to put forth visible effort. In contrast, Participant 3 positioned students as having a responsibility to contact the Office of Disability Services in order to secure their right to accommodations. If consideration is more readily given to students with and without official letters regarding disability status, instructors' assumptions and biases about what counts as effort, need, or worthiness may carry increased significance in the absence of broader departmental policies.

This excerpt constructs a version of neurodiversity that is not a disability, and does not have to be a difference if students make an effort and teachers provide accommodations. The use of "like" and "want" as the adverbs related to what the participant sees related to neurodiversity suggests that it is their choice and their personal "belief" and "comprehension." Included in this belief is that it is up for negotiation, depending on effort, whether neurodivergent students are regular or not.

In the Spring 2021 interview, Participant 2 recapitulated that neurodiversity is not a dysfunction, but instead is an opportunity that "regular people" do not have, stating "*And to me, is that the way that their brain works is different than regular people. But it doesn't mean that is dysfunctional, it is still functional. And the way that it works, it brings new opportunity, or new pieces to the table that regular people can't."*

This demonstrates a shift from working to construct a version of neurodiversity that is as similar as possible to "regular students" to acknowledging the difference, and the "new opportunity or new pieces" that are not available to "regular" people. This associates lack of ability "can't" with regular students. The flip here connects with a trend towards conflating neurodiversity with giftedness or twice-exceptionality, which assumes those who are labeled neurodivergent can do more than typical peers in some ways. The logic of more than/less than is important here as it points to a version of typical that is almost mathematical: what counts as typical can be added, missing, or balanced out.

Later in the interview, Participant 2 also described their framing of neurodiversity as strengths-based, as opposed to deficit-based (i.e., pathologizing and focusing on how people deviate from and fall short of the norm). Participant 2 stated "*we change our view from deficit-based to strength-based. So rather than calling neurodiversity disability, we call it like a strength, like, because these neurodiversity students are bringing something new to the plate and like, especially, I have, like junior senior students in my class, they will be working with neurodiverse people in their career. So rather than just seeing them with like that, a stereotype that okay, this person, maybe with autism or ADHD, they need help, right? They can change their view and says, okay, this person has a unique history. And so they don't have as a typical*

person, they can bring something new to the project. They're different or various because of a very unique strengths that they have."

Here the shift from neurodivergent students being *no different* from "regular" students goes even further by defining NDs by their very unique strengths. Their difference is "because of" their strengths, and their strengths are "very unique." The emphasis on uniqueness highlights again that the strength itself causes the difference, and the plural strengths similarly underscores strengths as the cause of difference rather than disability. Across a year of the project Participant 2 shifted in their talk about ND from a "no different from" to a "different because of unique strengths" construction. This has implications for how students are positioned relative to one another as well as instructor expectations of students who identify as neurodivergent.

Finally, Participant 3 stated "*Well, of every individual is different. And individuals are more different in terms of learning, in terms of how comfortable anxious versus non anxious, they feel, that different style learners and universal design in turn tries to address that by providing a accessible modalities everybody can learn and also flexibility to, to allow the different learners to do well, using the strengths versus things that cannot compete alone.*"

Table 2: Participants' Discursive Constructions of Neurodiversity

Participant	**Interview**	**Neurodiversity is…**
Participant 1	Fall 2020	A type of natural human diversity
Participant 2	Fall 2020	Universal, natural, differences
Participant 2	Spring 2021	A source of unique strengths
Participant 3	Fall 2020	A difference that should be accommodated

B. Views about Accommodations

In the interviews, participants also discussed their views on accommodations, which further illustrate their constructions of neurodiversity as it represents an official area of professional responsibility related to teaching diverse learners [39]. Accommodations are academic adjustments and/or auxiliary aids and services. In 2020 in a study of accommodations used by physics students, Scanlon et al. [40] found that the most commonly used accommodations were extended test time, flexible deadlines, extra time on assessments, flexible attendance, closed captioning, and quiet test environment. Similar trends were found in engineering courses at the University of Dayton [41]. Accommodations provide an important mechanism for reducing the

barriers to access and participation for students with disability labels and/or who are neurodivergent.

The ways participants described accommodations were similar to their constructions of neurodiversity as either a universally applicable phenomenon or a marker of difference. For example, some participants described accommodations as something part of their regular instructional practice. For example, in their fall 2021 interview Participant 3 stated "*on my first day of the lecture, I told the student that if you need accommodations, please contact CSD. And then I will get an official letter from them that you can. [the] policy, right?*"

In this excerpt, Participant 3 constructs a version of accommodations that do not apply to everyone, and that require an official process with a pre-specified chain of communication: the professor tells the student, who tells the local Office of Disability Services, who sends an official letter. The phrase, "[the] policy, right?" serves two functions, the first is to mark this process as policy, thereby depersonalizing it and granting authority. Ending with the question, "right?" further highlights the policy rather than the person by checking that this is indeed the policy. This works to position Participant 3 as following the policy, not stating or setting it. It also works to absolve them of responsibility for the nature of the policy. This aligns with a construction of neurodiversity that does not apply to everyone, and a construction of inclusion that is defined by compliance with university policy. Thus suggesting that changes to policy might change inclusive practices, but individual beliefs or understandings do not currently require such a change.

Similarly, Participant 1 stated "*But if they need accommodation, for example, time of submission, or if they need like, extra help, or whatever, I will be more than happy to provide. Right?*" Participant 2 does not reference a policy, a specific process, official letter, or involvement of the Office of Disability Services as Participant 3 did. However, they both use the contingent "if" indicating that this is not necessarily applicable to every student. If there are needs, however, Participant 2 reprises the phrase from their quote above, saying they are "more than happy to provide" accommodations. Like Participant 3, Participant 2 ends with the question, "right?" which works to minimize their own authority in stating they would be "more than happy to provide" accommodations. This positions Participant 2 as the provider of accommodations without the required involvement of a named entity or policy compelling them to provide them. It aligns with Participant 2's second interview where they view neurodiversity as bringing strengths not found in regular students.

In keeping with their universalized construction of neurodiversity above, Participant 1 described how accommodations can support neurodivergent and neurotypical students saying "*And I strongly believe that accommodating neurodiverse students is beneficial for all students. And*

indeed, everyone's different. And everyone has different learning styles and different brains. So yeah, it is, I think, the critical homework for us to solve as engineering instructor."

Like Participant 2, participant 1 takes responsibility for providing accommodations, but goes farther in saying that this is beneficial for all students, and the responsibility of the engineering instructor. By using "engineering instructor" rather than personalizing this, the participant continues the pattern of generalizing or universalizing by making the responsibility fall on "the instructor" rather than themselves or the Office of Disability Services. This constructs the need for accommodations as closer to typical, rather than requiring a separate policy and procedure.

Similarly, Participant 2 described that accommodations can be used to support students along other dimensions of identity stating "*I basically I officially received letters from [Office of Disability Services]. And then so they're automatically getting accommodation but also I have had a few cases of like family emergency or medical emergency. Again, I asked them to work with Dean of Students because just to make sure that there's enough [unintelligible] you know, like someone administrated they know what's going on with the students and then I have allowed I mean, just being flexible and I try I've tried to be flexible I also have a student from Army that, okay…he's away but I extend homeworks for him or extend quizzes for him. But also for like other cases. I've tried to be flexible with like giving them maybe more makeup options. And, you know, extending the deadline, so yeah, a few cases out of CSD I've had at least five or six cases*." This aligns with their views that neurodiversity is a normal part of human variation and thus should not be treated differently than other types of adjustments they make to support students.

IV. Discussion and Implications

Across participants, we found three distinct constructions of neurodiversity which each can lead instructors to implementing instructional practices supportive of neurodivergent students. Specifically, some participants use language to minimize the differences described by neurodiversity, while others emphasize the ways a combination of teacher will, student effort and specific accommodations can limit the difference. Finally, in one case the instructor's definition focused on the differences and matching these with appropriate accommodations as defined by university policy under federal law. These three ways of using language to construct neurodiversity in undergraduate engineering courses are similar to the discourses identified by Lester, Dostal & Gabriel [24] in their references to legal framing, universal framing or a diversity framing. These patterned ways of talking about neurodiversity are discussed in greater detail below.

The first construction, which includes a neurodiversity-as-universal repertoire in which everyone is considered neurodivergent in some way, is helpful in normalizing neurodiversity in that neurodiversity encompasses a wide range of neurological and cognitive experiences of

individuals. Additionally, if all students are neurodivergent, then this can motivate instructors to implement inclusive and domain-relevant teaching practices to support their students. However, this framing can minimize or erase the neurodivergent identity that some neurodivergent individuals hold. Additionally, this framing pushes instructors to implement inclusive teaching strategies to support all students rather than implementing strategies specifically to support neurodivergent students who can experience marginalization due to their identity (similar to interest convergence in Critical Race Theory) [42].

The second construction is focused on specific differences, and is aligned with the accommodations model adopted by most institutions of higher education (i.e., only certain people are neurodivergent and thus those students should receive specific, academic adjustments to overcome the inherent barriers to access and participation created by endemic ableism/disablism in society). This construction encourages instructors to consider the individual needs and experiences of students which can motivate instructors to seriously consider and reflect on the experiences of individuals. Additionally, this construction can motivate instructors to implement accommodations and adjustments that can support NDs' individualized needs. However, the individual construction of neurodiversity could also lead instructors to solely focus on accommodations as a mechanism to support students' access and engagement with the course and not to course-wide inclusive teaching practices, which could further stigmatize neurodivergent people [43] [44].

Finally, the third, strengths-focused construction positioned students who are neurodivergent as unique, rather than universal, with unique strengths and challenges not found among the general population. The move from a universal to a unique-strengths perspective differs from the other two because it interrupts the repertoire of universal differences but maintains the practice of providing universal supports for learning. This aligns most closely with discourses which value diversity and inclusion for its own sake, pointing out the unique benefits of doing so rather than engaging in inclusive practices as a matter of policy compliance.

While these constructions of neurodiversity differ, each could be useful for instructors to consider as they present multiple orientations to course design and the repertoires of talk individuals bring to social interactions that occur within and around courses. We suggest that future professional development opportunities explicitly engage instructors in discussions about these different versions, the ways that students are positioned, and the assignment of rights and responsibilities within each positioning.

Acknowledgements

This material is based upon work supported by the National Science Foundation under IUSE/PFE:RED 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. Singer, *Odd People in: The Birth of Community Amongst People on the Autistic Spectrum. A Personal Exploration Based on Neurological Diversity*. Sydney: University of Technology, 1998.

[2] W. J. Baumol, "Education for innovation: entrepreneurial breakthroughs versus corporate incremental improvements," *Innov. Policy Econ.*, vol. 5, pp. 33-56, 2005. doi: 10.1086/ipe.5.25056170

[3] K. Kazerounian and S. Foley, "Barriers to creativity in engineering education: A study of instructors and students perceptions," *J. Mech. Des.*, vol. 129, pp. 761-768, 2007. doi: 10.1115/1.2739569

[4] T. Armstrong, (2017). "Neurodiversity: the future of special education?" *Educ. Lead*., vol: 74, pp. 10–16, 2017.

[5] J. L. Haney, "Reconceptualizing Autism: an alternative paradigm for social work practice," *J. Prog. Hum. Serv.*, vol: 29, pp. 61–80, 2018. doi: 10.1080/10428232.2017.1394689

[6] P. Dwyer, "The neurodiversity Approach(es): what are they and what do they mean for researchers?," *Hum. Dev.*, vol. 66, pp. 73-92, 2022. doi: 10.1159/000523723

[7] A. Abraham, S. Windmann, R. Siefen, I. Daum, and O. Güntürkün, "Creative thinking in adolescents with attention deficit hyperactivity disorder (ADHD)," *Child Neuro*, vol. 12, pp. 111-12, 2006. doi: 10.1080/09297040500320691

[8] G. A. Shaw, and G. Brown, "Laterality and creativity concomitants of attention problems," *Dev. Neuro.*, vol. 6, pp. 39-56, 1990. doi: 10.1080/87565649009540448

[9] H. A. White, and P. Shah, "Uninhibited imaginations: creativity in adults with attention-deficit/hyperactivity disorder," *Pers. Ind. Diff.,* vol. 40, pp. 1121-1131, 2006. doi: 10.1016/j.paid.2005.11.007

[10] R. L. Sparks, J. Javorsky, and L. Phillips, "College students classified with ADHD and the foreign language requirement. Journal of Learning Disabilities," *J. Learn. Dis.*, vol. 32, pp. 169-178, 2004. doi: 10.1177/00222194040370020701

[11] C. M. Syharat, A. Hain, and A. E. Zaghi, "Promoting Neurodiversity in Engineering Through Specialized Outreach Activities for Pre-college Students," *J. High. Ed. Theory & Prac.*, vol. 20, 2020. doi: 10.33423/jhetp.v20i14.3856

[12] E. M. Scanlon, and J. J. Chini, "Ability profiles: A framework for conceptualizing dimensions of ability," in *Physics Education Research Conference 2018*. doi: 10.1119/perc.2018.pr.Scanlon

[13] A. R. Thompson, L. Bethea, and J. Turner, "Faculty Knowledge of Disability Laws in Higher Education: A Survey," *Rehab. Consel. Bulletin*, vol. 40, pp. 166-180, 1997.

[14] D Zhang, L. Landmark, A Reber, H. Hsu, O. M. Kwok, and M. Benz, "University Faculty Knowledge, Beliefs, and Practices in Providing Reasonable Accommodations to Students with Disabilities," *Remed. Spec. Educ.*, vol. 31, pp. 276-286. doi: 10.1177/0741932509338348

[15] K. Q. Baker, K. Boland, and C. M. Nowik, "A Campus Survey of Faculty and Student Perceptions of Persons with Disabilities," *J. Post. Educ. & Dis.*, vol. 25, pp. 309-329, 2012.

[16] M. A. Moriarty, "Inclusive pedagogy: Teaching methodologies to reach diverse learners in science instruction," *Equity & Excel. In Edu.*, vol. 40, pp. 252-265, 2007. doi: 10.1080/10665680701434353

[17] T. S. Love, N. Kreiser, E. Camargo, M. E. Grubbs, E. J. Kim, P. L. Burge, and S. M. Culver, "STEM Faculty experiences with students with disabilities at a Land Grant Institution," *J Educ. & Train. Stud.,* vol. 3, pp. 27-38, 2014. doi: 10.11114/jets.v3i1.573

[18] E. Schoen, M. Usyal, and C. D. McDonald, "*Attitudes of faculty members toward treatment of disabled students reexamined,"* Coll. Stud. J., vol. 21, pp. 190-193, 1986.

[19] S. Rao, "*Faculty attitudes and students with disabilities in higher education: A literature review*," Coll. Stud. J., vol. 38, pp. 191-198, 2004.

[20] M. Skinner, "*Faculty willingness to provide accommodations and course alternatives to postsecondary students with learning disabilities*," Int. J. Spec. Educ., vol. 22, 2007.

[21] M. V. Svyantek, "Missing from the Classroom: Current Representations of Disability in Engineering Education" In *ASEE Annual Conference & Exposition*, New Orleans, Louisiana, June 2016. doi: 10.18260/p.25728.

[22] J. M. Hughes, "*Progressing positive discourse analysis and/in critical discourse studies: Reconstructing resistance through progressive discourse analysis*," Rev. Com., vol. 18, pp. 193-211, 2018. doi: 10.1080/15358593.2018.1479880

[23] A. J. Sochacka, "*Rewriting Normal: A Discourse Analysis of TEDx Speeches on Neurodiversity and Autism*". Nor. J. Eng. Stud., vol. 21, pp. 166-194, 2022.

[24] J. N. Lester, H. Dostal, and R. Gabriel, "*Policing neurodiversity in higher education: A discourse analysis of the talk surrounding accommodations for university students*," Ethics and Neuro., pp. 52-66, 2013.

[25] A. Guzman, and F. E. Balcazar, "*Disability services' standards and worldviews guiding their implementation*," J. Post. Educ. & Dis., vol. 33, pp. 48-62, 2010.

[26] S. M. Acevedo, and E. A. Nusbaum, "Autism, neurodiversity, and inclusive education," In *Oxford Research Encyclopedia of Education*. doi: 10.1093/acrefore/9780190264093.013.1260

[27] R. Chapman, "*Neurodiversity and the social ecology of mental functions*," Pers. Psychol. Sci., vol. 16, pp. 1360–13722, 2021. doi: 10.1177/1745691620959833

[28] H. Taylor, B. Fernandes, and S. Wraight, "*The evolution of complementary cognition: humans cooperatively adapt and evolve through a system of collective cognitive search*," Cam. Archaeol. J., vol. 32, pp. 61–77, 2022. doi: 10.1017/S0959774321000329

[29] M. Chrysochoou, A. E. Zaghi, C. M. Syharat, S. Motaref, S. Jang, A. Bagtzoglou, and C. A. Wakeman "Redesigning Engineering Education for Neurodiversity: New Standards for Inclusive Courses" In *2021 ASEE Virtual Annual Conference Content Access*, Virtual Conference, July 2021.

[30] C. A. Wakeman, A. Bagtzoglou, and M. Chrysochoou, "Improving the Learning Experience of Neurodiverse Students in a Fluid Mechanics Course During the COVID-19 Pandemic," In *ASEE Northeast*, April 2022.

[31] E. M. Spingola, "Literature Review on Disability Participation in the Engineering Field" in *ASEE Annual Conference & Exposition*, Salt Lake City, Utah, June 2018. doi: 10.18260/1-2--30776.

[32] D. Edwards, and J. Potter, *Discursive psychology*. Sage Publications, 1992.

[33] J. Potter, M. Wetherell, M. *Discourse and social psychology: Beyond attitudes and behaviour*. Sage Publications, 1987.

[34] A. M. Pomerantz, "*Extreme case formulations: A way of legitimizing claims*," Hum. Stud., vol. 9, pp. 219-229, 1986.

[35] B. Davies, and R. Harrè, "*Positioning: The discursive production of selves*," J. Theo. Soc. Beh., vol. 20, pp. 43-63, 1990.

[36] M. Billig, *Ideology and opinions: Studies in rhetorical psychology*. Sage Publications, 1991.

[37] M. Wetherell, "*Positioning and Interpretative Repertoires: Conversation Analysis and Post-Structuralism in Dialogue*," Dis. and Soc., vol. 9, pp. 387–412, 1998. doi: 10.1177/0957926598009003005

[38] N. Walker, "*Neuroqueer Heresies: Notes on the Neurodiversity Paradigm*: *Autistic Empowerment, and Postnormal Possibilities*," 2021.

[39] United States, Rehabilitation Act, section 504, 1998.

[40] E. M. Scanlon, M. Vignal, B. R. Wilcox, and J. J. Chini, (2021). "Students' use of disability accommodations in emergency remote teaching," In 2021 PERC Proceedings.

[41] E. Harrison, "An Introduction to Disability and Accommodations in Higher Education (HE)" In *ASEE Conferences - Conference for Industry and Education Collaboration*, San Antonio, August 2018.

[42] L. D. Baber, "*Considering the interest-convergence dilemma in STEM education*," Rev. High. Educ., vol. 38, pp. 251-270, 2015.

[43] D. Kranke, S. E. Jackson, D. A. Taylor, E. Anderson-Fye, and J. Floersch, "*College student disclosure of non-apparent disabilities to receive classroom accommodations*," J. Post. Educ. & Dis., vol. 26, pp. 35-51, 2013.

[44] G. Mamboleo, S. Dong, S. Anderson, and A. Molder, "*Accommodation experience: Challenges and facilitators of requesting and implementing accommodations among college students with disabilities*," J. Voc. Rehab., vol. 53, pp. 43-54, 2020.