ADH… Disorder? Discoveries on ADHD and physics learning from collaborative autoethnography

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The prevalence of Attention-Deficit / Hyperactivity Disorder (ADHD) diagnoses has increased in the last two decades thanks to greater mental health awareness and access to mental health care. The number of students diagnosed with ADHD entering colleges and universities is also increasing, yet scholarship around effective pedagogical methods that cater to this population's strengths is severely lacking and remains largely deficit focused. After struggling to find published work on the experiences of adult physics students with ADHD, we set out to conduct our own research. Through our collaborative autoethnographic investigation we discovered that active learning environments such as those supported by the Learning Assistant (LA) Model cater to ADHD students' strengths due to their flexibility and adaptability to unique ways of thinking and processing. Furthermore, we found that these students' success was bolstered by the pedagogical and cultural changes in the department brought on by the adoption of the LA Program's evidence-based and equity-focused philosophy.

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I. INTRODUCTION

Students with Attention-Deficit / Hyperactivity Disorder (ADHD) make up approximately 8% to 11% of the undergraduate populations attending universities in the United States [1]. Although the matriculation of students formally diagnosed with ADHD in postsecondary institutions continues to grow, there are structural and institutional barriers that prevent these and undiagnosed ADHD students from succeeding in a university setting. This is particularly true of traditional STEM programs that adopt lecture-based formats and emphasize repetition while devaluing strengths typically associated with ADHD such as divergent thinking and creativity [2-5].

The available literature on adults and college students with ADHD has vastly improved in the last two decades with the addition of qualitative studies that meaningfully explore the lived experiences of people with ADHD [6,7]. Unfortunately, there are still gaps in the existing literature. Specifically, little research has focused on ADHD students in STEM undergraduate programs. This is a crucial area that could improve resources for STEM educators by providing strategies of support that cater to this group's strengths, rather than offsetting their supposed deficits.

Our research was initially inspired by Dr. Jessica Sedgwick's qualitative study examining the positive aspects of ADHD [8]. We set out to continue her team's exploration and provide more insight into the positive traits of ADHD. The current analysis is part of a larger ongoing interview study exploring the experiences of undergraduate STEM students with ADHD. In this analysis, we focus on identifying supports that improve ADHD students' outcomes in STEM, a setting that is otherwise structured without their success in mind.

II. BACKGROUND

A. Non-deficit focused research on ADHD

In the last two decades, the framing of ADHD in the literature through qualitative and mixed-method approaches has done much to improve our understanding of ADHD as a multifaceted condition [6,7]. One of the first and largest qualitative studies comes from a series of four cross-cultural studies conducted by the World Health Organization (WHO). The aim of the project was to develop and test international diagnostic standards for children and adolescents with ADHD (specifically a new diagnostic inventory: International Classification of Functioning, Disability, and Health (ICF)). Part of this process involved a qualitative investigation into "aspects of ability and disability" through interviews of children and adolescents with ADHD, as well as their parents/caretakers. Though it was not the aim of the study to identify strengths of ADHD, the researchers noted in their analysis and discussion that self-reports from participants overwhelmingly indicated that unique strengths comprised a large part of the ADHD experience and called for further investigation on the topic [9].

Sedgwick's study [8] answers this call, directly citing the results of the WHO study as the motivation for their focus on positive attributes rather than deficits of ADHD. Their study was designed with tenets of positive psychology in mind, which emphasizes "positive aspects of human functioning and flourishing (i.e. positive emotions, engagement, relationships, meaning and accomplishment)," rather than viewing mental health from a deficit-focused lens [8]. Criteria to identify traits unique to ADHD was based in the Character Strengths and Virtues (CSV) classification [10]. Analysis identified themes that spoke to positive traits which were categorized based on the CSV and themes that did not reflect one of the existing CSV categories were deemed unique to ADHD.

Additionally, there is a longstanding body of work, consisting of both qualitative and quantitative studies, by Holly White and Priti Shah (e.g., [11]) focused on the connection between ADHD and enhanced creativity. Their research builds off their 2004 landmark study "Uninhibited Imaginations: Creativity in adults with Attention-Deficit/Hyperactivity Disorder" [11] which suggested that broader semantic activation and diminished inhibitory control in people with ADHD improved their divergent thinking capabilities, which in turn assists in aspects of the creative process [2-5].

B. Active STEM learning environments and ADHD

Aside from these, and a few other qualitative studies investigating experiences of disability identity (e.g., [12]), almost no studies exist on the topic of positive aspects or inherent strengths of ADHD. To our group's knowledge, there are no existing studies specifically probing ADHD strengths in the context of STEM disciplines. This is a key gap in the current research, as these students' successful completion of STEM programs can offer insights into pedagogical strategies that go beyond compensation for perceived weaknesses and may in fact, promote greater student success by playing to ADHD strengths.

Many STEM undergraduate degree programs still place a premium on traditional modes of instruction such as lecture-based courses, repetition through problem sets, and timed exams [2, 4-5]. Furthermore, it has been illustrated in psychological studies on innovation and the creative process that STEM fields not only deemphasize crucial parts of the creative process such as incubation and divergent thinking, but in fact devalue them in academic settings [2-5]. Dr. Jacki Chini's team at the University of Central Florida is one of the few to investigate this specifically among physics students with disabilities (SWD) and their instructors. Through interviews with students, Chini's team found a consistent pattern of miscommunication between the physics SWD and their instructors [13]. Analysis of the interviews showed that the students struggled against instructors'

inability to adapt to their unique ways of thinking. Though the study was designed to sample all SWD as participants, all participants had ADHD, making this a particularly useful exhibit and one of very few to examine the intersections of ADHD and physics at the college level.

Conversely, active learning environments that allow for greater flexibility and exploration of course content through peer-to-peer interactions and hands-on projects and activities are consistently associated with more positive learning outcomes, such as improved overall test scores, average GPAs, DFW rates, and graduation rates, as well as classroom culture [14]. As such, active learning is also inherently more engaging for students with ADHD, because it fundamentally alters the traditional lecture-based format with peer-to-peer activities that require critical thinking and collaboration. Active learning also tends to favor an approach that is adaptable to varying thought processes, which is ideal for the unique ways in which students with ADHD learn [14,15]. The Learning Assistant (LA) Model developed at the University of Colorado Boulder [16] is one such active learning environment that has been adopted and implemented at many universities nationwide.

III. METHODS

We begin with our positionality with respect to this research. The first author is a queer, neurodivergent Latina and recent physics graduate of Texas State University (TXST). After discovering a passion for teaching and education research, she has set out to contextualize her journey as a student with ADHD in academia with the goal of reforming gatekeeping aspects of academic culture that have barred other marginalized students both like and unlike her from full participation in knowledge-seeking and self-discovery. The second author is a current, non-traditional physics undergraduate student at TXST diagnosed with ADHD, whose previous life experience has netted him a bachelor's degree and a fulfilling career in the military. The third author is a tenured Associate Professor of Physics at TXST, and is director of the Physics LA Program there as well as the instructor for the LA pedagogy course. She does not have (diagnosed) ADHD. This analysis is focused on a single interview from the broader study, in which the first author (Kaleigh) interviewed the second author (Anthony). At the time of the interview, Anthony was not yet part of the research team; he signed on to assist with the project the following semester.

Given both authors' roles as former Physics LAs at TXST and as students formally diagnosed with ADHD, and in light of the gap in research on this population, we felt it necessary to provide answers to the overarching question: "what is it like to be a student with ADHD in a STEM major?" As such, we adopted a methodology of collaborative ethnography wherein both authors participated in the interview process (first author as interviewer, second author as interviewee).

Autoethnography is a research method that employs self-reflection and observation within a qualitative thematic framework to document how individual subjectivities shape social interactions. This method is particularly valuable for exploring strengths, challenges, and insights that involve the researcher themselves, and acknowledges them as agents of construction of a scientific narrative [17,18]. It also provides a way to understand aspects of how meaning is constructed and shared among social actors. Thus, it transcends narration and self-reflection to engage in cultural analysis and contextualization. Collaborative autoethnography takes this method and extends it from self-reflection to joint reflection between two researchers viewing themselves and each other as the subjects.

Our overarching goal as education researchers is to shift the dominant narrative of ADHD in academia. Currently the discourse is largely shaped by the medical model of disability, which frames all disabilities–and by extension, ADHD–exclusively as individual defects or aberrations borne of physiological differences. This inherently marginalizes those with disabilities by casting them as inferior agents whose failures can only be attributed to their disability, while ignoring other limitations posed by their environment [19]. While there is some merit to articulating the unique traits that exist within the spectrum of neurodivergence, the medical model frames these differences solely as defects. We felt that collaborative autoethnography was the best way to shift focus to positive aspects, because it acknowledges the researchers' expertise in their own experiences as STEM students with ADHD.

As with all interviews in this study, this interview was conducted by the first author using a semi-structured interview protocol to guide the discussion. Because the study is meant to be open-ended and exploratory in nature, the questions in the interview protocol were used to provide scaffolding for self-reflection and observation. Thus, many tangents and alternate topics were explored in order to gain insights into the participants' unique experiences. The interview process was completed in one two-hour session and was conducted by the first author during her last semester as an undergraduate. Interviews were transcribed verbatim and core themes were identified in collaborative analysis discussions between all three authors.

IV. INTERVIEW DATA AND ANALYSIS

In this analysis we focus on an interview wherein Kaleigh, the first author, interviewed Anthony, the second author. This analysis focuses on identifying positive supports for the success of both interviewee and interviewer as they pursued their physics degrees. While the data provided many intriguing findings, the two broad themes we present here are a) the importance of active learning, particularly as supported by the LA Program, and b) the value that adaptive learning frameworks like the LA Program can bring to the culture of physics departments.

A. LA Program structures support active learning and normalize diversity

The LA model is designed to support student-centered instruction [15], and LAs are taught to encourage students to articulate and build on their existing ideas. These practices have been shown to broadly increase student success [15]. Our study finds these practices to be especially important for supporting students with ADHD.

1. Student-centered instruction normalizes differences

By design, the LA Program supports instruction that is responsive to students' ideas and thought processes [15]. Inherent in this structure is the expectation that students bring unique and diverse experiences and backgrounds to the classroom, and that their perspectives are valuable and necessary to the learning process. Students who serve as LAs read and discuss research articles reinforcing these values (e.g., [20,21]), and have opportunities to facilitate discussions with groups of students in ways that elicit different ways of thinking. Anthony reflected on this experience:

> *We talked about the pedagogy, like the shared mental model(s)… And you start to see how different people think a little different… you start figuring out, if I'm trying to explain something this way, and it's not going anywhere, I can try this other way… you start to get good at seeing how people are responding to different ways to communicate with them.*

Because this instructional culture treats individual differences as expected, rather than anomalous, it supports a learning environment that is more accepting of students with ADHD who may be more different than average in their ways of engaging with learning.

2. Active learning sustains attention

In addition to recognizing and valuing individual differences, the interactive learning supported by the LA Program encourages sustained attention. Anthony addressed this when he contrasted his experience in LA physics courses with his other lecture-based courses:

> *…taking a math course like differential equations that is just a lecture the whole time is so maddening. ...I don't make it anywhere near the end of the lecture before I'm way off in space. But the interactive stuff we do in the lower-level physics classes, where everybody's around the table and [with the] LAs… I respond to that better. Just being talked at [makes me] lose interest.*

While sustaining attention in a lecture-based course can be pose challenges to all students, students with ADHD have a broader scope of semantic activation, which causes greater attentional variation, interactive instruction is of particular benefit to these students' engagement with course material.

3. LAs share student identities

LAs are a diverse group, representative of the student population, which means students often find an LA with whom they share important identity membership. This both normalizes diversity (including neurodiversity) and provides opportunities for peer mentoring. Anthony commented on making such connections through disability disclosure with students in his role as LA:

> *…but I've certainly worked with the students, as an LA, who maybe had ADHD or dyslexia or some kind of thing going on. And if they're open about it, I'm totally all about being open too … you know, it helps with a relationship.*

In fact, both authors discussed their experiences with disability disclosure in the LA pedagogy course, and Kaleigh noted that this led to them becoming unofficial LA advocates for the needs of neurodivergent students.

B. LA pedagogy course influences department culture

The LA Pedagogy course supports LAs in developing understanding of how people learn and in valuing collaborative community. These values have influenced the broader culture of the TXST physics department beyond just those courses supported by the LA Program.

1. LA pedagogy course emphasizes equity and inclusion

At TXST, the LA Pedagogy course emphasizes issues of diversity, equity, and inclusion, and explicitly values the work of supporting students from traditionally under-represented groups. LAs read articles on topics such as stereotype threat [22], gender bias [23], and the myth of meritocracy [24], and discuss how these phenomena influence students' perceptions of themselves and others in the classroom. During the interview both Anthony and Kaleigh reflected on how these conversations helped them re-interpret their previous experiences in a way that increased their sense of belonging in the physics community. Kaleigh makes explicit reference to this here:

> *[In] the Physics Department at Texas State University, taking the pedagogy course and finding belonging there in that community that sort of recognizes the differences… I knew what belonging looked like. And [I] never really previously had known what that looked or felt like before.*

For Kaleigh, the recognition and valuing of differences among community members supported her sense of

belonging. Anthony extended these themes to the specific experience of ADHD:

> *We had conversations about gender roles in pedagogy. And at some point, you've got to ask yourself, "[Does] this particular thing have really anything to do with gender?" And I start to wonder that about ADHD too… maybe it's a disorder if you're trying to function within a system that resists this sort of thinking?*

Thus, while the current LA pedagogy readings do not specifically address the experiences of neurodivergent students, they are sufficiently expansive to encourage LAs to question the normative culture of physics and to identify and reject implicit messages that they do not belong in the physics community.

2. LA culture supports flexible course structure

The TXST Physics Department and the LA Program are intertwined and influential over one another. The student-centered approach and active-learning environment, both inherent in the LA Model, influence the department culture by creating a more open dialogue between students and faculty, and promote research-based methods of instruction that favor adaptability and flexibility in course structure and content delivery. This in turn creates a more harmonious classroom environment, and improves power dynamics and relationships between faculty and students. While the Physics LA Program at TXST primarily supports the introductory course sequence, most upper-division physics courses are now also taught using interactive and student-centered instructional methods.

It is common for physics instructors at TXST to use less traditional testing formats that allow for students to demonstrate understanding in a variety of ways. It is also typical for faculty to informally allow extended time on assignments and exams for any student who requests it, regardless of diagnosis; this benefits many students who for a variety of reasons, do not have official accommodations through the Office of Disability Services. Kaleigh described this flexible and supportive learning environment as essential to her success as a physics major:

> *When it comes to assignment deadlines …the other thing that is so great is the Texas State Physics Department. I think I would not have been able to graduate were it not for landing there. Just because… the culture for me to succeed was already somewhat built in… so I've worked with a lot of [physics] teachers. I'm kind of finding the sweet spot in terms of the right amount of structure, but not so much that it's going to stress me out and set me up for failure.*

Faculty willing to entertain greater flexibility outside of traditional, rigid modes of instruction is an extension of the values supported by the LA program and is aligned with the principles of equity and inclusion emphasized in the LA pedagogy course.

V. CONCLUSION & CALL TO ACTION

There is broad consensus in the literature that interactive instruction benefits student learning and success (e.g., [25]). Our analysis shows that in addition to this result, the student-centered and equity-oriented version of interactive instruction in our physics department specifically supports the success of students with ADHD, who learn differently by default. The implementation of the LA model promotes these students' success because it caters to attentional variations inherent in ADHD through an active learning environment. Furthermore, it provides a supportive department culture where neurodivergent students are not reduced to their perceived "deficits," but rather embraced as multifaceted human beings.

There was a time in history when left-handed primary school students were forced by stigma, or in some cases outright punishment, to use their right hands. Today, it is easy to see this was misguided. We contend that the current deficit-based outlook on ADHD, influenced by the medical model of disability, is as misguided as forcing left-handed students to write with their right hands. We further contend that it not only marginalizes neurodivergent students, but it deprives STEM fields of these students' unique perspectives and undiscovered talents. Instructors and education researchers are in a powerful position to adapt learning environments that allow for more flexibility, support in-class engagement, and foster a greater sense of student belonging. We implore the academic community to rethink their assumptions about neurodivergent students not just in the classroom, but in research as well, by engaging neurodivergent faculty and students in more exploratory modes of research such as autoethnography.

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