

Where Resources End and Teaching Begins: Experience with Students with Autism Spectrum Disorders in the Freshman Engineering Curriculum

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Abstract

A growing number of students diagnosed with an autism spectrum disorder (ASD) are enrolling in science, technology, engineering, and math (STEM) curricula in college. This paper focuses on first year engineering students, and the importance of accommodating students with an ASD through their academic career. It is becoming more common to have a student with an ASD in the classroom. Colleges have a variety of resources to assist ASD students, however some students will sign up for this assistance, while others do not. Beyond the college resources the instructor must fill in the gaps to ensure student success. First, the instructor must recognize the ASD student's learning style. The needs of the student and the learning styles vary by individual. For freshman year instructors it may be difficult to determine these needs in a timely manner, since most students do not self-disclose their disability. Observation and communication with the student are key in this step. Many first year engineering courses utilize individual and group work with both written assignments and "hands-on" projects including writing, drawing, problem solving, scheduling, budgeting, and craftsmanship. The diverse skillset and behaviors exhibited during these classes help give the instructor insight on the student's strengths and interests. Next, the instructor can provide accommodations in the form of enhanced group work and/or individual work, direct communication, and guided learning techniques. This is a continuous process for the instructor, where some needs may not be met or recognized in a single semester. Having a diverse student population also impacts the students working alongside the ASD student. Through proper direction and encouragement from the instructor, the students become more conscientious team members. Finally, it is important for the freshman instructor to communicate with other instructors in the curriculum path to allow a fluid transfer of accommodations for the ASD student through his/her academic career, thus providing better preparation for employment after college.

Background

Autism is a spectrum disorder which affects people differently and can range from very mild to severe. Due to changes in the specifics of an autism spectrum disorder (ASD) diagnosis and much more awareness of this spectrum disorder more children have been diagnosed, which has led to a growing population of adults with an ASD^{1,2}. This growth is also due to higher-functioning ASD adults that may not have been previously diagnosed³. The term high-functioning ASDs also includes Asperger syndrome and pervasive developmental disorder not otherwise specified^{1,3}.

Most support for this spectrum disorder has been targeted towards children and teens, however this assistance has naturally led to more ASD students pursuing postsecondary education^{4,5}. There is little research on this transition from high school to college which has contributed to a gap in their personal growth as ASD students approach adulthood⁶. Students with an ASD who

have had positive high school experiences, face additional difficulties in college due to changes in living situations, socializing, and taking more responsibility for their educational success. Adults with average or even above average intelligence with an ASD have trouble completing college and finding meaningful employment⁷. This can be due to a multitude of reasons, from social interactions, to difficulty with the classroom setting or classroom rules, to faculty with limited understanding, and finally inadequate assistance during the job search process. With the proper support an ASD student can be successful in college and beyond. When ASD students attend regular college courses with rigor and have success it gives them self-esteem and a sense of belonging⁶.

ASD students in college

Colleges and universities want a diverse student population, including learning differences among the students. As more students with ASDs are attending colleges and universities these institutions are starting to realize the challenges associated with educating the ASD student^{6,8}. For the most part there is little widespread awareness among the faculty and students at these postsecondary institutions regarding the unique challenges faced by students with an ASD.

Among those diagnosed with autism, more people suffer from milder forms of an ASD¹. Not much has been published on how the ASD symptoms appear in the college classroom⁵. Due to this lack of knowledge, and slight learning differences among the students, this can be an invisible disorder in the classroom. Many college instructors lack the awareness and understanding of ASD students, and the distinctive challenges they face in the classroom.

The students with an ASD are generally excellent students that may exhibit some discriminating behaviors. Their presence is sometimes very noticeable to the students and the instructor in the class⁹. Some needs are easy to recognize and others are much subtler. Some traits exhibited by an ASD student may include difficulties with verbal and nonverbal communications, problems taking turns in conversations (the student may monopolize the conversation or may not speak at all), speaking in a loud tone, speaking in a soft tone, having issues with some forms of humor, being preoccupied with certain subjects, asking a lot of questions, not asking any questions, sitting in the middle of people, sitting in the corner away from people, making eye contact, not making eye contact, possessing higher abilities in rule-based thinking, having anxiety in social settings, or having difficulty connecting with others^{3,9,10,11}. There is not a specific set of traits that identifies a student with an ASD. In the previous list there were many traits that contradicted the prior trait listed. This is due to the disorder manifesting itself differently in every ASD student. Typically, deficits in communication and social skills are present¹².

Students with an ASD select science, technology, engineering, and math (STEM) areas of study at a higher percentage than the general population, and other differently-abled groups^{11,13,14}. The reason for the interest in STEM majors can be explained by the systemize vs. empathize theory. A person's propensity or dislike of these two factors characterize an ASD¹⁵. To systemize is to construct a rule-based system to explain the surrounding world, and to empathize is to have emotional reactions to other people's thoughts and feelings¹³. Many of the same skills needed to systemize are also needed in STEM fields. People with an ASD usually have a much greater tendency to systemize than to empathize, thus making it natural for a student with an ASD to

gravitate towards STEM fields^{13,15}. Even with this interest in STEM, ASD students have one of the lowest overall college enrollment rates compared to other disability categories¹³. Many of the traits of an ASD student may blur the line with common traits/interests that draw non-ASD students to the STEM fields¹⁶. In Trevisan & Birmingham⁷ students with STEM majors scored higher on the Broad Autism Phenotype traits and lower on the social adjustment scores than their non-STEM major peers.

College resources

Many high-functioning ASD students are intellectually capable of attaining a college degree, oftentimes they need supportive accommodations for both academics and gaining independence^{1,14}. The Americans with Disabilities Act (ADA) states that a public institution cannot discriminate against individuals with disabilities. Postsecondary education has to conform with the ADA, but not the more stringent Individuals with Disabilities Education Act (IDEA)¹⁷. That is why many colleges do not have programs in place for ASD students beyond what they offer through a general disability resource center (DRC). However, a small number of colleges do have ASD-specific programs¹⁷. As the ASD student population increases, this trend of ASD-specific programs will increase. Colleges need to offer additional social supports to ensure ASD students are academically successful¹. The support offered at a college is not as individualized as the support an ASD student receives through his/her primary and secondary education. As a starting point, it is recommended that the student use an individualized education program (IEP) from high school as a reference for services needed at college^{1,3,6}. The IEP serves as documentation of the student's needs and indicates that the student was successful academically with the accommodations provided. The IEP contains modifications and services provided to the student during high school regarding the classroom setting, homework, test taking, and any other services needed. Once ASD students reach college they have to take more responsibility and self-advocate^{3,6}. The ASD student should register with the DRC so he/she is eligible for the accommodations in the classroom and so that faculty are made aware of these modifications¹. At college most students are responsible for initiating this contact with the DRC. Taking the initiative for this interaction may be difficult for a student with an ASD^{3,7}. Typically the DRC communicates with the faculty in a confidential manner, however the student may need to discuss with the individual faculty the modifications he/she needs to be successful^{3,6}. Faculty at colleges usually do not make changes to the class materials, or classroom alterations unless the instructor receives official documentation from the DRC regarding a student's accommodations. Students attending college for the first time may not know about the possible modifications, and may not be eligible to receive this support until late in the semester. Some students may avoid the process completely, or simply realize the support through the DRC does not meet their specialized needs. Many colleges offer notetaking service, more time on tests, no distractions during testing, and materials in an alternate format through their DRC. The ASD student may require different accommodations than what is offered. At Achieving in Higher Education with Autism and Developmental Disabilities in Pittsburgh students at local colleges are given assistance with social interactions and time management, but they still meet the same academic requirements as other students⁸.

Ultimately, it is the student's responsibility to let the instructor know of his/her needs¹⁰. Faculty typically follow the guidelines suggested by the college's DRC, and are encouraged to reach out

to the student regarding these accommodations. A student with an ASD should work closely with the instructor since the student may have sensory issues or specialized needs that are not obvious. However, due to institutional policies, and faculty or peer reactions to autism, many ASD students do not self-disclose their condition¹⁸. It is not the instructor's place to make this diagnosis or assumption, but rather to simply support the students for academic success.

Engineering education

There is a shift in engineering education where the faculty give students technical content along with social context, critical analysis, and ethical consequences of their work¹⁹. A more general approach where the students understand basic engineering principles, but also the ability to research and learn more specialized knowledge as they need it, is more common place in engineering education¹⁹. Many freshman engineering classes use individual and group work, "hands-on" projects, written communications, and oral presentations as an introduction to future engineering coursework. Research shows improved learning outcomes and higher retention rates when students are involved in an interactive learning environment¹¹. Employers have concurred with this by requesting more focus on oral and written communications, teamwork, and overall professionalism¹¹. Some of the skills during the freshman engineering class include problem solving, drawing, scheduling, budgeting, and craftsmanship. Usually during this first semester of freshman engineering the students are involved in several projects and some specific skill building activities. The students typically learn some basic computer coding, basic circuit and motor operations, how to create and update a schedule, how to keep track of a budget and purchase materials, how to take measurements for a design and account for efficiency, how to test a design, how to write a proposal, and how to give a presentation. The projects may be fairly ambiguous, such as "build a tower", some students thrive on this vagueness, while others do not. Some projects are much more defined with proposals, schedules, and budgets as a part of the process to the final design. With all these skillsets on display this is a good place for faculty to identify the potential needs and/or strengths of a student with an ASD. Most students with an ASD solve problems in creative, unconventional ways¹². The ambiguous project may be an area for the ASD student to research and thrive, while some ASD students will appreciate the more directed project with rules and requirements. However, the scope of the guided project may be overwhelming if presented all at once. A large project assignment should be broken down into smaller steps/assignments with varying due dates. For example, the instructor provides due dates for the proposal, progress reports, Gantt chart completion, bill of materials, and project construction. The students are still required to meet the rigor of the class by actually developing the Gantt chart, determining the scope of the project and the materials needed, and writing the technical documents. Within the project work some ASD students gravitate towards craftsmanship and pay close attention to the details of the design. Others, prefer working with the numbers, by keeping track of the schedule and the budget for a project. Personal interaction during the project work time allows the ASD student to trust the instructor and lets the instructor give guidance on proper teamwork and social interactions.

Support from faculty

Engineering faculty may not be aware of a student with an ASD in the classroom, let alone have had training on how to help the student. Instructors who support classroom diversity and have

active learning environments with team projects, may need additional resources to successfully handle the needs of ASD students and their peers in the classroom¹¹. The ASD student may have issues interacting and working in teams, since it can highlight interpersonal skills^{5,12}. Because of this some ASD students prefer individual work over group work¹². The instructor should monitor the group to ensure the ASD student is assigned work and is a productive member of the team. Most ASD students need positive interactions from the instructor to perform well in the class.

Some ASD students have a high aptitude for one particular subject⁸. Instructors can use this interest to motivate the student in the classroom. The instructor can incorporate this interest in the classroom discussion, perhaps it can be part of a larger project, or simply an individual project that the ASD student must write about or create. Some other academic accommodations the instructor can make are clear and direct (no sarcasm) classroom expectations, asking precise questions, answering a set number of questions from the inquisitive student and then making him/her see the instructor after class, giving more time on essay type tests, hands on learning, performing demonstrations, breaking down large assignments into smaller units, using task analysis with multiple subjects to build a schedule with individual tasks, and providing positive reinforcement at every opportunity^{1,5,10,12,18}. Next, the instructor can provide accommodations in the form of enhanced group work by making sure all the students are actively participating and communicating during this work time, and even suggesting activities for the team members. If the student with an ASD needs more of a challenge he/she may be given more directed individual work, particularly in an area that interests the student. It is best for faculty to have direct communication with the student and to guide the student when necessary to keep him/her on task. Finally, it is important for the instructor not to get frustrated, and to keep communicating in a direct and positive manner with the ASD student.

College students also need information or guidance to understand their ASD student peers. Students having a relative with an ASD have an increased understanding of the ASD student⁴. Nevill & White⁴ found that peers majoring in engineering and physical sciences were more accepting of the behaviors of an ASD student than those majoring in social sciences. Nevill & White⁴ also found that engineering students reported the vignette character with an ASD in the study to be less different from themselves as compared to students from other majors. The faculty has to have awareness on how to effectively support the ASD student without hindering the classroom experiences of other engineering students. Having diverse learning peers leads to more compassionate, well-rounded students for future employment. However, during group work the team may need direction with assigning appropriate individual tasks, and help with keeping individuals on task. This process helps develop more contentious team members. The students become more aware of their strengths and weaknesses, and learn how to use these attributes to work together for success on a project. ASD students do not want the course content modified, the level of academic rigor should remain the same for an ASD student⁶. Participation with peers at the college level is essential for an ASD student to grow socially and academically.

Some practical examples of ASD student interactions in the classroom are given below.

- Encouraging a student who does not take notes to keep a notebook with class notes.
- Acknowledging the student's salutation during every class period.

- Reminding a student to go to the lab bench to finish a craftsmanship assignment. The student probably would not have gone to the bench without reassurance from the instructor.
- At the end of the class or during office hours, directing a student as to which assignments he/she should finish that week. Especially when the student focuses on work that is weeks ahead.
- When a student fixates on a classroom feature, speak directly to the student and help him/her refocus on the task at hand. If this involves disrupting a lecture, thank the student for pointing out the feature and politely ask the student to sit down and address the issue after class.
- For team work, help find tasks when the student is distracted and direct teammates on appropriate tasks for the student.
- Off topic conversations sometimes go too long during team work time, have all the team members refocus.

These are techniques used with all students, however they are more prevalent or even exaggerated with the ASD student. These instances need to be addressed in a direct manner, and not ignored, for the ASD student to successfully continue in his/her academic career.

After the first year

If a student has unique challenges, these need to be communicated to the faculty along the educational path for the student to have a smooth college experience. All the student needs may not be met or identified in a single semester. However, the typical freshman engineering class is a good indicator of the student's skills and interests. In Hart, Grigal & Weir⁶ faculty members discuss the positive impact the ASD student can have on the peers in the classroom and the college community as a whole. The social environment may be the most challenging aspect of college for an ASD student⁶. Peer mentors can help with this by modeling appropriate social behavior⁶. The ASD student peers' level of acceptance also affects the level of social connection or isolation felt by the ASD student⁴. In some instances, a social/education coach might be helpful to highlight the student's strengths and to support the student through his/her academic career and into finding employment¹¹. The hope is to better the experience as the student continues his/her academic path. This continued support will help the student grow and gain professional skills.

Beyond the college degree

The lack of services after high school means many individuals with normal to above normal intelligence may be on a path to unemployment or underemployment, social isolation, and poor quality of life²¹. According to Uditsky & Hughson²² 10-50% of adults with an ASD are employed, with approximately 80% of the jobs being part-time. The lack of research in the area of college students with ASDs leads to a considerable amount of unmet human potential and loss of productivity in our society². Faculty help students achieve a higher education, especially those students who may have never been given the opportunity in the past. A college education prepares students for the work force through developing good study habits, helping students gain independence, and becoming more contentious about their work. ASD students who attend college are more likely to have a positive employment outcome⁶. Through the college process

the ASD students not only learn technical knowledge and social awareness, but also more about their place in the world²⁰. Still some ASD students with a college degree end up being underemployed relative to their educational qualification²². It is important to have a liaison between college and work to help the ASD student attain a satisfying job and an improved quality of life.

According to Neary, Gilmore, & Ashburner²¹ parents rated employment support as the greatest service to their ASD children, this was followed by assistance to complete college, assistance for the transition from high school to adulthood, and social skills training. Employer engagement is under-developed for students with an ASD, employers need to connect with students with ASDs who are willing to work²². This creates diverse workforce and different problem solving skills among the employees. Some ASD students can notice particularly small differences and pay particular attention to detail, which is an asset in some fields¹⁶. Support for individuals with ASDs should be sustained, rather than offered only early in the employment²². Uditsky & Hughson²² suggested collaboration between the ASD student, parents, teachers, and other stakeholders to successfully plan for an independent adulthood.

Conclusion

Freshman engineering faculty regularly see ASD students during their first semester in college. This is a good environment to investigate and implement ASD-specific accommodations. Faculty in these classes see a multitude of skillsets and challenges the ASD student might face. The freshman engineering faculty can offer basic modifications, support, direction, and encouragement to all their students during this multidimensional class. This classroom support helps with retention rates within the major and success for students with inadequate college accommodations. However, outside of the classroom the faculty can work with the DRC to promote awareness of this spectrum disorder. Also, to help students academically and socially for success in college and with future employment, Hewatt¹⁶ suggested freshman engineering faculty work with Applied Behavioral Analysis (ABA) students to bring a social presence to their classroom. If ABA students are not available, graduate students in the Special Education field with interests in ABA or autism, or in the Engineering Education field would be useful. Graduate students in the education field can offer time management and social support to the students. Here at Arizona State University, part of our charter states “ASU is a comprehensive public research university, measured not by whom we exclude, but rather by whom we include and how they succeed”. Postsecondary education faculty need to be aware of ASD students since they want the “same opportunity for success, not the right of success.”¹⁰

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