Proactive Inclusion of Neurodiverse Learning Styles in Project-based Learning: A Call for Action

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Proactive Inclusion of Neurodiverse Learning Styles in Project-Based Learning: A Call for Action

Abstract

This paper discusses policies and accommodations that enable an inclusive and welcoming design course environment for students with a variety of identities, including students with non-visible disabilities. Design is an integral part of engineering education at Olin College of Engineering. In Olin College's largely project-based curriculum, students spend much of their time in design teams. These courses can present barriers for students with disabilities who are entitled to the same access to learning resources, including classroom culture, as their peers. Project-based courses present a wide range of challenges for students with disabilities, including, but not limited to, the ability to fully participate in hands-on learning and as a contributing team member. As larger numbers of students with identified non-visible disabilities enter engineering schools, and engineering schools increasingly adopt project-based design courses, the question of accessibility in these design courses becomes increasingly relevant.

There are many publicly available best-practice resources for making learning environments accessible for students with physical disabilities in educational spaces, such as fabrication and lab environments. Despite an increase in students reporting non-visible disabilities in higher education, there has not been a commensurate number of resources dedicated to understanding how to make learning environments more accessible to them. As educators embrace open-ended design and studio practices, it becomes more and more difficult to anticipate needs of individual students with a large variety of disabilities. We present a case study with a student persona and some proposed solutions, which are a departure from traditional accommodations focused primarily on lectures and exams, and to motivate a call for action to develop more resources for all students.

Introduction

The average number of college students reporting a disability has continued to increase, with 11.1% in the most recent data available from the Department of Education [1]. Notably, a more recent report on mental health in higher education found up to 35% of students have met the criteria for at least one mental disorder in the prior 12 months, which suggests that the total number of students with disabilities in our classrooms is higher than the reported figures [2]. This increase in reporting has led to many much-needed discussions regarding physical accessibility in the work spaces commonly found in engineering colleges, and means that matters of accessibility for a changing population are especially salient. It is notable that accommodations for students with non-visible disabilities have been less well explored. As experiential education and project-based learning become more prevalent in colleges and universities, we must explore potential accommodations for non-traditional classroom settings. There are few recommendations for how one might adapt traditional accommodations for students with non-visible disabilities in hands-on learning spaces and open-ended project-based courses. While many common barriers for students with non-visible disabilities are encountered in any type of classroom or design space, the application of universal design strategies can produce a pattern of best practices that transcends the physical learning environment.

Olin College has a slightly higher than average number of students who have reported a disability, about 12%. There is a dearth of students reporting a disability during our rigorous and personal admissions process, with many more students disclosed their disability after being admitted. This may indicate a perception that disability is a liability in a student's chances of being admitted to college. Recently, we have also seen an increase in the number of students coming forward with non-visible disabilities throughout the semester, as they encounter different barriers to their education and, perhaps more poignantly, as discourse about disability and neurodiversity becomes more widespread. While students may be increasingly comfortable disclosing that they have a disability, they may still be reluctant to use accommodations, as they may fear discrimination or the appearance of an unfair advantage [3]. At Olin College, students have described both guilt about using accommodations, as well as trepidation about how disability disclosure could affect their reputation. Reputation at Olin College is particularly important, as the school is very small and students in each cohort take largely the same classes.

Olin College's curriculum and approach to teaching are different from those of a typical engineering school. Many courses have significant projects, often produced in teams. Project assessment is generally based on individual students' learning goals, which are vastly different from student to student. A do-learn approach means that many classes do not have a typical lecture, homework, or test format. This hands-on, highly individualized learning environment means that typically prepared, exam- and lecture-based accommodations are not always an option, and gives us the opportunity to think creatively about student needs. Additionally, Olin College consists of a small, close-knit campus of well-integrated students, faculty, and staff. The size of the community coupled with the individualized, project-based curriculum puts Olin College in a unique position to explore solutions to accommodate the varied needs of neurodiverse students.

Background

A neurodiverse student body includes students with non-visible disabilities. These can include, but are not limited to, students diagnosed with any number of psychiatric, sensory, mood, and learning disorders. This can also include physical disabilities, such as low vision or chronic fatigue and migraines. In other words, these are students with diagnoses that indicate that they have particular barriers in how they experience the world, but these barriers are invisible to others without the students' active disclosure. These barriers can impair students' abilities to equitably access their education.

As institutes of higher education respond to increasingly higher numbers of disclosed disabilities, there is some indication that reporting is still not where it needs to be. The 2016 Healthy Minds Study suggested that up to 35% of students enrolled in higher education institutions met the criteria for at least one mental disorder in the prior 12 months [2]. This statistic indicates that the rate of reporting dramatically underrepresents the number of students in need of accommodation and demonstrates the importance of universal design in all classrooms to truly serve all students.

Universal Design Principles (UDP) were introduced in 1997 in order to make space more usable for people with diverse abilities by a group of architects, product designers, engineers and

environmental design researchers to describe a philosophy of design for all [4]. The application of universal design principles to ensure equitable access to engineering spaces has received greater emphasis as the number of engineering students with varying abilities has increased. This is particularly true as the rise of the "maker movement" has championed hands-on learning and DIY culture [5]. With an increased emphasis on project-based education, making, and collaborative learning, comes the need to ensure the accessibility of the spaces and resources that enable these interactions to take place.

Previous work in this area has mainly focused on physical spaces, and provides an excellent set of best-practice guidelines to make shared fabrication spaces accessible to a variety of users. The Disabilities, Opportunities, Internetworking, and Technology (DO-IT) center at the University of Washington [6] provides an extensive repository of resources related to accessibility and universal design, in particular guidelines for both engineering labs [7] and makerspaces [8]. The Accessible Biomedical Immersion Laboratory (ABIL) at Purdue University [9] and the Seattle Lighthouse for the Blind [10] also provide excellent recommendations and models. Recommendations are broken down into guidelines for physical environments, tools and hardware, and instructional and support resources. Open floor plans with clearly marked and accessible routes of travel are a priority in accessible work spaces, with reconfigurable and height-adjustable workstations also emphasised to accommodate individuals of different stature and mobility needs. Considerations for height, physical strength, and vision need to be considered when selecting tools for shared fabrication spaces. Both staff hiring and training, and instructional materials, need to be designed with all types of learners in mind, though with a focus on individuals with physical disabilities.

Ensuring that makerspaces provide equitable access to all individuals has spurred the application of universal design principles to shared fabrication spaces, especially in non-traditional settings like libraries[11] and [12]. In the context of a medical library, Meyer et al. focus on the concept of a blend-able makerspace, or "makerspaces that support people with abilities and as far as possible, also with their disabilities and special needs." By emphasizing universal design and participatory ergonomics, guidelines for spaces and tools, as well as instructional materials and staff were produced. Looking beyond physical spaces, Alper focuses on the creation of "mixed-ability maker culture" or " a collaborative culture within which people with and without disabilities can co-exist and co-create as they work to maximize and develop their own skills" [13]. Alper applies approaches used in designing children's creative computational tools to activities, tools, and pedagogy within makerspaces to encourage people with and without disabilities to co-exist and co-create.

In recent years, Universal Design Principles, which were initially focused on physical spaces, have been extended to learning environments. The branch relating to learning environments specifically is called Universal Design for Learning, or UDL. A working definition for UDL, adapted from Riviou by Miller and Lang, is a framework that "involves providing many curriculum delivery formats and teaching strategies in order to maximize the learning and engagement of students with a variety of learning styles and needs, while benefiting everyone in the process[new citation, Riviou]][14,15]."

Miller and Lang address how UDL can be incorporated into science laboratories, specifically to address students who experience stress in the lab environment, and provide a practical framework for implementing recommendations, many of which address proactive, inviting communication between faculty and students. Burgstahler and Russo-Gleicher offer similar recommendations for students with autism spectrum disorder [16] Hua et al. provide an exploration of how inquiry-based instruction can be combined with communities of practice to the benefit of students who are both gifted and diagnosed with ADHD, notably recommending,, "a role shift between the teacher and the learner, wherein the teacher negotiates the balances between teacher directedness and student choice, while actively looking for ways to learn from his or her students within the instructional experience [17]." Recently, we've seen literature challenging educators to go further, tying accessibility to justice [18] in libraries and equitably-consequential learning [19] in STEM and engineering makerspaces.

The Association on Higher Education and Disability (AHEAD) provides a number of resources and recommendations for ways college students and faculty can support students with disabilities and what reasonable accommodations may look like in a classroom setting [20]. In addition to the resources outlined above, the DO-IT center at the University of Washington provides suggested accommodations for students with learning disabilities, psychiatric disabilities, and other non-visible disabilities as well as suggestions for faculty and educators in the classroom and others on campus working with technology.

At all universities, letters of accessibility address these concerns as best they can, and an emphasis on project-based, collaborative learning can mitigate many of the associated difficulties of being a neurodiverse student. For example, because Olin College has very limited test-based evaluations, students who would normally require extra time on exams no longer use this particular accommodation. One major challenge, however, revolves around providing one student on a team with an extra time accommodation, without inadvertently forcing the student to disclose their disability to their peers.

Existing Guidelines at Olin College

In the past year, several conversations between Disability Services (DSO) at Olin College and students registered with DSO have taken place. Through these discussions, two patterns emerged. According to students with neurodiverse needs, much of the stress and anxiety about having a non-visible disability and working on projects with team members would be mitigated by a stronger campus awareness and recognition that neurodiverse differences exist. Raising the level of general awareness, both inside and outside of the classroom, will positively impact comfort and reduce stigma for students with non-visible disability. Reducing the stigma surrounding non-visible disabilities will enable students to advocate for themselves and activate their accommodations. Additionally, efforts should be made to alleviate physical barriers to cognitive function for neurodiverse students, such as sound and visual intrusions in a classroom or lab space. In order to further alleviate barriers to access, one can designate work spaces in acknowledgement of different learning needs. This active participation can shift the classroom culture from one of overcoming disability to accessibility and open communication about priorities.

Discussion

Olin College of Engineering was founded with the mission to educate exceptional engineering innovators and change engineering education. The college is a private, undergraduate-only institution with approximately 350 students and 44 full time faculty. Approximately 40% of Olin College's curriculum is common across all majors, with engineering design and hands-on, project-based learning prominently featured. All Olin College students take an introductory design course in the first semester of their first year, in which each student individually designs and builds a mechanical system before participating in a team-based final project. It is common for Olin students to be enrolled in at least one course every semester in which they are expected or required to make something – from mechanical toys, to autonomous robots, to circuits and software – often with a team.

Olin College's small size means, on one hand, that we lack the student support resources available at larger schools. On the other hand, faculty and student life staff get to know, and work closely with, students. Our small size also means that faculty can be engaged partners who work closely with student life professionals. The high level of communication amongst groups means that individuals working with students have existing relationships, which creates group accountability for student support; we are aware of problems that individual students are having. A faculty member might check in casually with a member of the student life staff to let them know a particular student is struggling in their course. A culture of feedback among the students also means that students feel empowered to give feedback and to advocate for changes. Because of the faculty's autonomy and flexibility, we can often respond in real time to requests from students and adjust to best meet the students' needs. Also, because of these various levels of communication, we have a sense of successes and failures. The constant communication of a small community means that results, or lack thereof, of student successes are transmitted in real time. This makes active engagement in best practices a more possible landmark to achieve on a school-wide level. Olin College's small, close-knit community enables us to immediately explore potential solutions to addressing a neurodiverse student population, solutions that can then be scaled to larger institutions.

Infrastructure and Space Accommodations

Like most universities, Olin College is working with existing buildings and thus must develop strategies that work within them: we have limited opportunity for major modifications. One major challenge is that many courses are taught in a "studio" format, in which a number of teams work in a classroom at the same time. Students with attention disorders or sensory sensitivities may have a hard time focusing in that environment; a growing awareness about the needs of these students among faculty has led to increased emphasis on allowing students to work outside the classroom. Faculty must create the space, both physically and socially, for this option so that the student seeking the accommodation can enjoy similar benefits of their learning environment as their neurotypical peers. Regardless of physical parameters, an open and stated commitment to creating a classroom that is effective for a variety of learning styles reduces the need for attention-drawing accommodations or accommodations that obviously single out a student in a classroom.

One of Olin College's simplest, yet most effective, solutions for a common accommodation is to make a general statement to the class about different learning and processing needs, and actively give permission for students to take their groups to a quiet area or work in a different environment. In making this broad statement at the beginning of class, professors enable students with non-visible disabilities to comfortably ask their team to move to a quieter location without feeling the pressure of disclosure. Additionally, a classroom can be set up so that students could move to a smaller workspace, and then return with the group to report back to the classroom. This workspace is a separate room dedicated for use by students with learning differences and is situated close enough to the main classroom that the students do not have to travel far to rejoin the class. While classroom space is always a concern, enabling students to separate from the classroom while working on project work is a solution that is accessible to institutions of all sizes. Providing this space, while openly acknowledging learning differences amongst students, enables students with both the freedom and acceptance to address their learning needs how they see fit. Furthermore, presenting this statement at the start of the semester when instructors are establishing a classroom culture signals accessibility as a priority to the class.

Classroom culture at Olin College is very flexible. It is entirely ordinary for students to be working on different aspects of the project at hand, using different tools, going at different speeds, and interacting in their own way with the space, their classmates, and the instructor. This culture means that allowing a student to work outside the classroom is a small extension of the existing structure rather than a major deviation from the norm, as it would be in many other institutions. Creating a flexible, accepting, and open culture from classroom to classroom, rather than focusing on a blanket solution on an institutional basis, would enable larger institutions to meet a greater number of neurodiverse needs.

Case Study

Profile of a Student Persona

Meet Ella, an 18 year-old, white woman from Buffalo Grove, Illinois, who comes from an upper middle class family. Ella was diagnosed with ADHD Not Otherwise Specified (NOS) as well as Generalized Anxiety Disorder (GAD). She was evaluated at age 6 and again at 14, when the GAD was diagnosed. In both of these evaluations, she demonstrated weakness in processing speed and executive functioning. She performed at a superior to very superior range on different language assessments and in her general intellectual ability based on vocabulary, word reading, and non-verbal, visuospatial reasoning. Her learning and memory tests were in the very superior range. Her executive functioning test showed some vulnerabilities in areas of attention and processing speed. She did not show strong frustration tolerance, often becoming visibly upset at timed measures or when she believed she was not answering the questions correctly. Ella demonstrates perfectionist tendencies, rigid thinking patterns, and anxiety around test taking. According to various mood measures, Ella exhibits severe anxiety with mild depression and hopelessness. While being tested, Ella was highly engaged and fully oriented to the task at hand. She was highly motivated to do well. Ella now takes medication for the ADHD but is not being treated medically with anti-anxiety medication.

High School Information
Ella attended Stevenson High School, a school consistently ranked as one of the top public high schools in the country. Stevenson High School has nearly 4,000 students enrolled. Services related to individualized instruction, disability and counseling services, and academic support are widely available and easily accessible. Ella spent a lot of time in various clubs, including FIRST Robotics, various bands, and was President of the Pokémon club. Ella also volunteers at the local chapter of the ASPCA. She is accustomed to having many resources available to her, as well as having a plethora of organized clubs and student groups. She regularly utilized study hall hours and received private academic coaching throughout high school. She did not require academic accommodations in elementary or middle school. Ella earned a 4.1 GPA/4.0 weighted GPA in high school.

Academic Accommodations
Ella had a 504 plan in place in high school that detailed several academic accommodations. She was eligible to receive several academic accommodations related to her disabilities:

- Up to 50% more time on all tests and quizzes.
- Take tests in a private room with limited distraction.
- Meet bi-weekly with her instructors to go over her assignments and plans for the following weeks.
- Seating near the door in the classroom and permitted to leave the classroom as needed.

Family and Social Supports
Ella's family is heavily involved and invested in her success. They have maintained regular contact with the high school to ensure that they know about Ella's progress in school. Ella's mother works with Ella in the evenings to go over any homework assignments or other requirements that Ella may forget about due to her ADHD. She also helps Ella with prioritization of her schoolwork and various club obligations. Her mother also helps her to remember to take her medication every day.

Ella enjoys a strong and close-knit community of friends. She is well-liked by peers and teachers. She is described as highly empathetic with a great sense of humor. Ella is open about how she deals with ADHD and Anxiety and has served as a Peer Tutor to other students who may struggle with similar concerns.

The Course
The course we are using for this case study is a first-year design studio course that culminates in a major group project. The final project involves creating a physical device designed for a particular user group. For the first half of the semester, students learn about the design process and learn key prototyping and shop skills by doing an independent project. In the second half of the semester, students are placed on teams of four to repeat the design process, now in a group, to design and build their device. While the entire class may meet in a large auditorium periodically for group instruction, students are typically in studios with about 30 students, 2 faculty, and 2 undergraduate teaching assistants. Students sit at tables around the open room,

while faculty and teaching assistants circulate during class time. The classroom is open for project work outside of class hours.

Most instruction is personalized and informal, including informal design reviews and consultations held between faculty and teams. For each of the projects, the process is broken down into discrete sections with milestones as students move from sketching and brainstorming, to proposing mechanisms, to creating sketch models, to creating CAD rendering of parts, to creating those parts and testing prototype function. Periodic class-wide design reviews are conducted, during which faculty, teaching assistants, and peers give feedback. The final project is also presented at a campus-wide demo-day that includes visitors, who give students feedback, from outside the college. Learning objectives and assessment are based primarily on student process and reflection, rather than concrete technical goals. Students also have a a high degree of autonomy in defining the specific trajectory and outcomes of their projects. This, combined with a group of incoming students with an array of backgrounds in design and fabrication, means that each project, and process, is unique. Thus, the course of each project and the advice given to students at any point may vary. Advice is typically given verbally.

Because of the open-ended nature of projects and process-driven emphasis of assessment, students transitioning from high school can find this course challenging. They are often uncomfortable with the decrease in summative feedback they are used to receiving and unsure of how they are doing.

Here we will primarily focus on the experience in the group project. As part of the team formation process, students are presented with information about how to maintain team health and given a brief introduction to some tools to do so. In order to reinforce the emphasis on process and learning, they are also asked to reflect on individual learning goals, and the team is held responsible for helping each member meet those goals. Next the team moves into an initial ideation phase. They then meet with a group of potential users to get some feedback on their initial concepts, before transitioning to a cycle of prototyping and testing that lasts until their final demo.

Challenges

This example highlights the potential limitation of typical legal accomodation letters, which often include instructions that relate to a more traditional lecture and test-based classroom model, but do not envision studio-based, hands-on learning environments. It also highlights some relatively simple, potential modifications to every learning environment that can provide an equitable learning space for a greater number of students. While a modified learning environment can help students feel more comfortable expressing their needs, Olin College's small, intimate nature has also enabled the creation of individualized letters of accommodation. Highly individualized accommodation letters, combined with a close working relationship between faculty members and disability services staff members, lead to a greater understanding of student needs and how best to accommodate them while considering the unique approach to learning and teaching at Olin College.

One of the initial difficulties in accommodating Ella's needs in a course like this may spring up as the course begins. Ella's challenges with executive functioning combined with her high anxiety and former reliance on a regular planning with instructors may not coincide well with a course that is individualistic and self-paced. Such a course may not typically have a syllabus with clearly defined deadlines. Also, because instructors and faculty members are responding in real time to student work, being able to anticipate or plan for long-term learning objectives becomes very difficult. Progress in this course is a moving target, which provides agility and flexibility in learning goals and responsiveness, but may also present unique challenges for students who already struggle with prioritization, planning, or who rely on routine and structure to encourage productivity and focus.

Despite great progress in general classroom management, many difficulties in accommodating Ella in a course like this come toward the end of the project process, as deliverables are due and publicly reviewed. The public nature of the deadline makes it difficult to provide extended time for her to work on the project; extended time can affect the rest of the team and potentially expose Ella's need for this accommodation. Faculty often approach this by adjusting expectations to align with the available time since they are unable to adjust the time to allow for meeting expectations. In a pass/fail course with a vast variety of project outcomes, adjusting expectations slightly often works well, as students are still typically within a reasonable range of outcomes. However, if the expectations within the course were more narrowly defined, and particularly if letter grades were given, the adjustment of expectations raises a new set of questions about how one might assess fairly under these conditions.

Public design reviews and demo days may heighten Ella's anxiety, and the setting may also make it difficult for her to focus. If the demo days are merely an assessment tool for faculty and but not fundamentally linked to a particular pedagogical goal, then this warrants consideration of alternatives that might benefit Ella specifically. For example, Ella could be exempted from the public demo and be assessed in a different mode. However, exempting her might advertise to the class that she requires accommodation. A more universal design approach in this case would be to offer all students different approaches for assessment. If the public demo days serve a fundamental pedagogical purpose in preparing students for public engagement or facilitating their ability to explain their design to others, then exempting Ella would no longer be considered a reasonable accommodation. Faculty currently handle these situations on a case by case basis, working with the specific student and their specific needs. Ultimately, Ella must participate in the design reviews and demo day along with her team. Ideally, the faculty member would work with Ella and Disability Services to come to an arrangement that enables her to fully participate.

Recommendations and Future Work

Universal design best practices should be at play in any course. This means having a clear syllabus with clearly laid out expectations [21], including schedules, encouragement to meet with faculty and other support services, and assignments, which is especially important for open-ended courses like this one. While lectures in courses like these are sporadic and sometimes only delivered in response to student needs at a given time, they often become fairly consistent in courses that have been taught multiple times. If possible, instructors should create written notes, slides, and videos of material so students can engage in the different mediums at

their own pace. Further, for courses like this that do not rely on a text book, providing students with relevant materials in a variety of accessible formats can be helpful for as-needed access. Even resources with discipline-specific subject information can be helpful for students like Ella. An outline of an expected timeline for assignments can enable all students to better manage both their time and their expectations regarding the course.

Many typical accommodations are hard to map onto group work. During the teaming process, it is important that the instructors create space for Ella to express her needs without having to disclose her accommodations to her peers. One approach is to scaffold the teaming process by requesting that students create a team agreement. Instructors provide a worksheet-style template to allow students to reflect on key prompts regarding, for example, preferred work and feedback styles (See Figure 1). At the beginning of the teaming experience, students mark their own preferences and needs on each spectrum in the worksheet and then discuss with their teammates to understand each other's needs in order to jointly create their team agreement. This is an opportunity to explicitly frame questions such as "What do I need in an environment to be successful?" For some students, this might be a positive attitude, but for those who need to leave the loud studio space to work more quietly, this gives them a chance to voice this. To that end, it is important that instructors anticipate examples like this and give students explicit permission to work in a quieter area if there is a loud classroom environment. Giving students the power to ask for what they need is empowering for everyone, and this aspect of teaming prompts all students to ask for what they need, which in turn allows Ella to make requests without standing out.

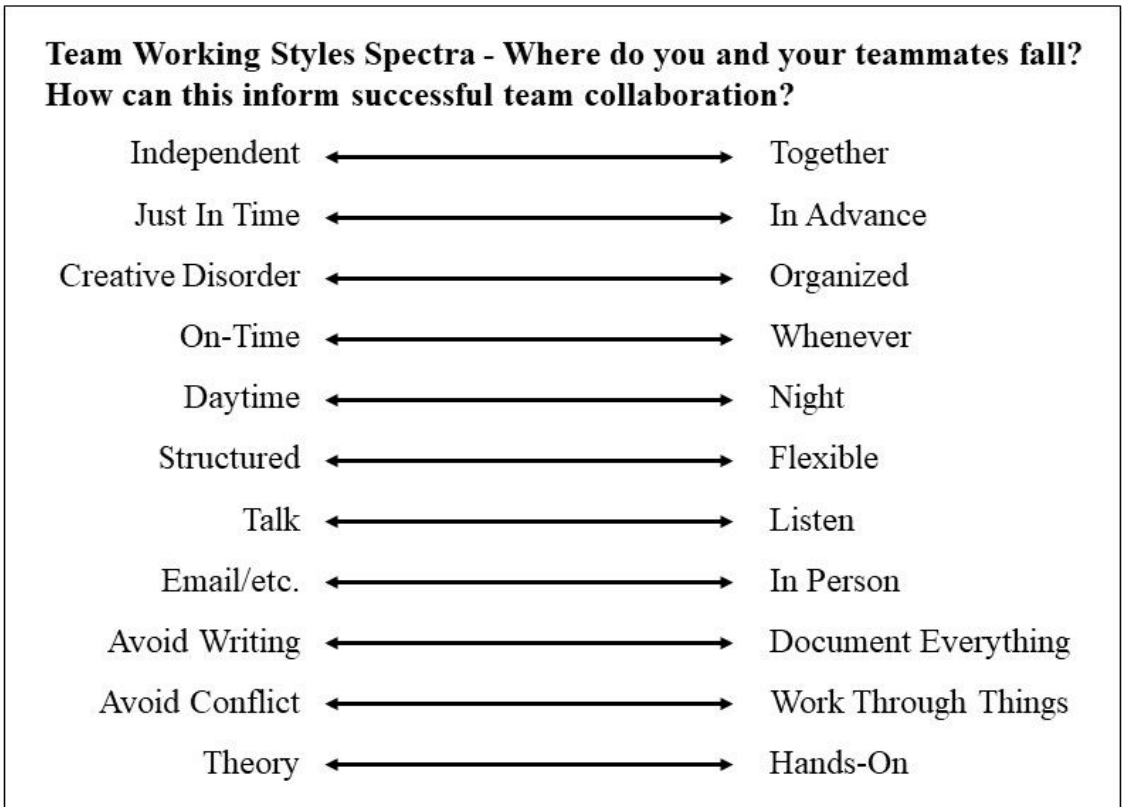

Figure 1. Team Working Styles Spectra for scaffolding teamwork.

In an academic environment focused on individual learning goals and each team's independent process, faculty feedback can often be informal and spontaneous. Informal feedback can be challenging for students to remember, which can cause anxiety for some students. While it might change the workflow faculty are accustomed to, there is great benefit to capturing feedback and advice in writing. This can be done by faculty, teaching assistants, or by the students themselves. Receiving written feedback spurs students to reflect and synthesize their experience in class and produce a tangible expression of that experience. In addition to making the advice more concrete for students, it provides faculty a record of past feedback on which they can follow up. Teaching students how to maintain records of feedback and advice not only provides a scaffolding that is beneficial to students like Ella, but prepares students for the documentation requirements found in the majority of the working world.

Documentation and structure are helpful tools to support Ella through many aspects of a course like this. In addition to capturing feedback and discussions in writing, providing structure and templates, when possible, for the more anxiety-producing aspects of the course will help Ella be more comfortable and more able to succeed. For example, when students meet with external stakeholders, the uncertainty involved can produce considerable anxiety. Suggestions can be provided about meeting in a location that is conducive to optimal performance and learning for all involved when location is not a critical piece of the experience or educational outcome. As with all reasonable accommodations, careful consideration of learning outcomes must be considered so as to create proactive solutions rather than inadvertently reinforcing avoidant behavior. Templates for how to structure those types of interaction can also be helpful for students. They can provide suggestions for the flow of conversation, questions or prompts to get the discussion started, and ideas for how to address any conflicts or challenges that might arise. This type of scaffolding is particularly appropriate in a course like this, in which students are being introduced to these activities for the first time.

Design reviews can be structured to reduce anxiety as well. The goal of the design review should be made clear, and should focus on students' progress toward their own learning goals, rather than on achievement against an external metric. Focusing on learning goals in design reviews reduces the possibility of comparing students' contributions. Even when external metrics are necessary in assessment, the feedback given in reviews can focus more on how the students might move toward achievement rather than on how the students are falling short. Additionally, allowing students to comment on their own design reviews, and co-create their assessment, can reduce anxiety while encouraging them to practice self-assessment and reflection skills.

Including frequent, informal design reviews throughout the process can help to relieve some of the pressure that builds up around formal reviews and give students an opportunity to build expectations and practice receiving feedback in a lower stakes environment. In larger institutions, highly structured peer-to-peer design reviews can relieve some of the burden on already overburdened faculty member. Students can practice receiving feedback in a low-stakes environment, while learning how one examines someone else's process. Design reviews provide structure for a project's timeline, as they are opportunities for driving work forward rather than

letting it accumulate. Reviews are also opportunities for managing scope, as well as for intervening in situations when a student is not doing well in the team environment.

These issues and strategies are likely applicable to not only project-based learning environments in academic institutions, but also to makerspaces in academic and community-based environments that are growing in number and popularity. As a movement towards creating accessibility in making progresses, it is important that a universal design approach be taken to designing makerspaces as well.

Conclusion

Olin College of Engineering's institutional vision is to transform the undergraduate engineering learning experience by continually developing new teaching approaches and environments. Transformation of learning experiences and *development of effective learning environments* is central to our identity. As an engineering and design school with a heavy emphasis on hands-on, do-learn projects, we are a natural center for exploration into physical and social environments that provide the best possible learning experiences for students with a vast range of needs. We are committed to creating a diverse student body, and as dialogues regarding distinct learning styles become more prevalent, so too does the definition of diversity expand.

Primary and secondary education is changing. The conversation about accessibility for visible and non-visible disabilities is becoming more prevalent. As accessibility in elementary, middle, and high school changes, new doors open for neurodiverse students, which leads to engineering colleges seeing a wide range of student needs. As our community includes more neurodiverse and physically diverse students, our vision and mission demand that we transform and develop environments to give each and every one of them the most effective learning experience possible.

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