



**Current SIUE
Students'
Discussion on
STEM Education**

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Introduction

We are SIUE STEM Student Ambassadors Zackary Woodall, Sylvia Lopshire, and Cameron Coleman. We are undergraduate students here at SIUE who were given the opportunity through the STEM Ambassador program that is funded by the Howard Hughes Medical Institute (HHMI) to conduct research on STEM education at SIUE. We were tasked with finding ways to increase student retention, engagement, and accessibility in STEM classes at SIUE. To this end, our group decided to hold focus groups for current STEM students to hear directly from them what problems they were facing in pursuing their STEM education.

We designed our project with a framework that revolved around what is known in education research as the Universal Design for Learning (UDL). The essence of UDL is a set of principles that strives to create a teaching environment that is engaging and accessible for all types of students. The basic principles are providing multiple means of engagement, multiple means of representation, and multiple means of expression for students. We believed that applying this type of framework to STEM courses, even in higher education, would be important for creating a classroom environment that facilitates true learning for all students and not just memorization of facts, or the success of a narrow margin of students. We constructed our focus groups with these principles in mind.

Focus Group Prompt Questions:

When was a time you felt as though you did not belong in STEM?

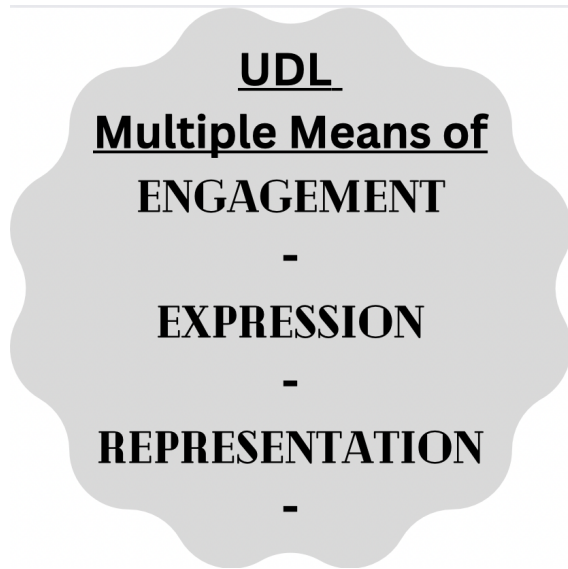
Can you think of a resource/tool/method that you have encountered in your intro STEM course that facilitated your success as a learner?

What is something you would like to see incorporated into STEM education?

Our five focus groups consisted of 24 STEM students across all STEM related departments at SIUE with a focus on introductory courses. Students were participating in or had completed classes such as Bio 150 and 151, Chem 121A and 121B, Math 150, IE 106, Phys 131, and of course all the laboratories associated with their respective courses. We asked participants about teaching methods they had encountered and what they felt helped them learn the best. They were asked about what kinds of techniques they wanted to see incorporated into their STEM education, and also discussed how all of this factored into their sense of belonging as a STEM student at

SIUE. We chose not to inform participants about UDL or its associated principles; however, what we found were responses that made clear alignments with the UDL framework. Our focus groups were loosely facilitated discussions prompted by three questions: “When was a time you felt as though you did not belong in STEM?”, “Can you think of a resource/tool/method that you have encountered in your intro STEM course that facilitated your success as a learner?”, and “What is something you would like to see incorporated into STEM education?”.

We used UDL guidelines as the framework for organizing our participant responses. This allowed us to structure our data in a way that we could easily convey the small changes instructors can make to create a more accessible teaching environment in their classroom. The three themes of UDL that stood as the principles by which we categorized our responses are multiple means of engagement, representation, and action/expression. We observed these core



divisions of accessible and inclusive education as aligning with what students at SIUE responded with in the focus group setting. Below is a short description of each, adapted from the CAST Universal Design for Learning webpage.

<https://udlguidelines.cast.org/>

Multiple Means of Engagement: Multiple means of engagement focuses on the fact that each student learns and is engaged in a different way, and encourages instructors to build their course in a way that allows for students to have choice (autonomy), real world connections with what they are learning (relevance), and developing community within the classroom for feedback and

increasing goals and ambition. Based on this definition, we categorized the following focus group themes. Our students strongly expressed how interactions with the professor and the professor's availability directly influence their experience and satisfaction in class. Students mentioned how a professor's attitude toward the material strongly influenced how likely they were to ask questions during class or visit them privately during office hours. They appreciated professors who were enthusiastic about their subject, clearly cared about student enjoyment in the course, and conveyed the value of the work the students were putting in as it pertained to their desired careers. Multiple students also discussed the benefit of professors having flexible office hours, or when a professor provided their schedule as part of their syllabus so if a student's schedule wasn't compatible with the specific office hours, they were able to find a compatible time to meet with their instructor and eliminate some of the back and forth of trying to find a mutual free time. Additionally, communication availability of professors, and their receptiveness towards questions was frequently mentioned by students in the focus groups.

"if you ask a question, the teacher asks for your name. The connection is there...so it's all personal, because [they] always ask for your name. If you ask a question, [they] answer the question, what not, it just seems like it's more focused on the people. He's not just talking out in the open. "
-Focus Group Participant

"they're a nice teacher to be around, so it makes you enjoy the class, even though it can be difficult. You feel more entitled to want to do more in that class and actually learn more, rather than just watch a PowerPoint from someone who hates their job."
-Focus Group Participant

While professor-student communication is key, participants called for more options for student-student communication. Students asked for more collaborative assignments and outlets for connections. For example, a computer science student mentioned that there is a Discord group full of current computer science majors, graduate students, and even alumni. This is a perfect outlet for students to ask questions and interact with their classmates. This outlet, or a similar option via Blackboard or another platform, could be easily created by a faculty member with little maintenance and low faculty engagement required. Students also expressed how they felt more engaged when there was a clear connection between what they were learning and a real-world application or future career application. When instructors provide even a brief synopsis of how the educational content applies to a real career, the students become more excited about what they are learning.

"there's a slide or 2 on like, real life application to connect the concept to whatever it is that can be used in real life, which I think is really helpful, for like, grounding it for the students, especially if it's a unit that somebody may not be that interested in"
-Focus Group Participant

Furthermore, we found that students frequently mentioned a disconnect between the material covered in lecture and the material covered in lab, PLTL (Peer Led Team Learning, a small workshop as part of the course), and Supplemental Instruction (SI). Students mentioned that at times it seemed as though the expectations in the lab were not clearly conveyed from the instructor to the Teaching Assistants (TA). This caused the TAs to be unable to help students with certain lab material and the whole exercise seemed pointless to the students. They also mentioned that the pace of PLTL sometimes speeds ahead of lecture and causes the PLTL leader to become a stand-in teacher for that lesson. Another student

mentioned that because of the miscommunication with the professor and SI instructor, they were told conflicting lessons on the same material. However, students in all of the focus groups

emphasized how helpful having these resources has been in courses where they were organized and on track. Finally, students wanted professors to perform a learning check in with them periodically throughout the semester. This could be something as simple as a poll gauging student understanding of course material or a checklist of concepts that students need to have down to keep them on track. Students appreciated receiving feedback directly from the professor on their specific mistakes to isolate and correct their misunderstandings over the course of the class, not just on exams.

"incorporat[ing] what the labs were doing into what we're actually learning lecture-wise helps to reinforce what they're wanting us to know, like the key concepts. And so I think that's very important, repetition in what you're doing and making sure that it actually applies to what you're doing."

-Focus Group Participant

Multiple Means of Representation: Having multiple means of representation focuses more on how students comprehend information presented to them due to culture, ability, or other backgrounds that may change the connections students make with the material to grasp concepts. This principle encourages learning environments that offer options for accessing material that clarifies it, displaying content through multiple media and resources, guides information processing, and clearly defines patterns, ideas, and relationships in the course content. Students called for more representation in class projects and professor expectations.

"an example could be giving options for different types of assignments. So, you know, all assignments around the same skill set, but give, 'Hey! Here's 3 options for programs you could do.'"

-Focus Group Participant

For instance, students brought up lab projects in our focus groups and how when they feel confined to one type of project they are less interested in it. Students advocated for professors to provide multiple ways to meet the same learning goal through a varying amount of projects. Giving students options to be creative in labs or larger class projects keeps them engaged in the material. This generation of STEM students know that in their future careers they will have some freedom to reach their goals in the way that they find best. Allowing students to have some type of control over the experiments they perform will give them a greater sense of purpose in the class and

in any STEM career. Moreover, students repeatedly mentioned how professors begin classes with many assumptions of student knowledge prior to taking the class. This seemed more prevalent in first year student and international student responses due to their varying educational background. Freshman students may have gaps in their STEM educational pathway due to lack of class availability at their respective high schools. International students face a new cultural environment as well as a new curricular environment that may always pick up exactly where they left off in their home country. Students explained how these gaps in foundational material put them behind in the class because their professors brushed over it and were unwilling to cover

it when asked. These students called for either more professor flexibility or at least a brief list of foundational topics that students may need to know to understand the current course material so they could review it on their own. Some suggested some supplemental materials, such as pre-recorded lectures just so they could easily acquire the knowledge needed to be successful in the course on their own time. Students expressed that the more professor-created materials provided, the better, so they could have a better understanding of the course's content and how to navigate how that specific instructor ran it, including what the professor wouldn't cover but students needed to know.

"[they say] like 'you should know these', and if you don't, you can have a week in the beginning of the semester. Be like, 'get these terms, remember them. Try to review them, and if you don't remember, come to my office hours.' It's like an 'Oh, if you know all these things, then you're good to go to learn next week.' kind of thing be beneficial, I think to everyone."
-Focus Group Participant

"I really like how my professor gives us the online material that was used during covid times, like the online lecture, so that I can watch those ahead of time, so that when I go to class, it makes the class so much easier."
-Focus Group Participant

"I'm an international student, the things that I learned back in my country and here are not the same thing, but in the class, they just come up. And then, like 'you should have learned this for the class, [assuming] that you had taken it before that'
-Focus Group Participant

Multiple Means of Expression: The final principle, multiple means of action and expression, focuses on how learners navigate their learning environment in terms of organization, strategy, and expressing their progress. It encourages instructors to allow for options in student response methods, optimizing access to various tools, and aid students in goal setting, managing information, and monitoring progress.

"I'd like to see our professors cooperate with the tutoring center as well. I feel like that would benefit everybody."

...
"if there was a little cooperation with the professors, like, they could just send an intro to what they are doing so I can give [the tutor] an outline to their semester."
-Focus Group Participant

To provide another means of expression students called for study guides provided by professors. Many students mentioned that they study independently with review sheets provided by the professor. This could be in the form of review questions or a list of important topics that should be reviewed before the exam. Students appreciated courses in which the expectations were clearly communicated by the professor and if there was a disconnect there, the outside resources were prepared to help effectively. Additionally, students have been experiencing trouble with the tutoring center because of lack of communication between instructors and the tutoring center.

Participants said that the tutoring center had frequently been recommended to them by their instructor if they were struggling in their class. However, when students found a tutor for their class they were unable to help because they had never covered some of the topics being taught in the class. This was very discouraging to students that

not even their tutors were able to assist them. Students proposed that more communication between the professor and tutoring center would fix this, and optimize this resource. By providing the tutoring center with their syllabus beforehand, the tutors would be better equipped to assist students who are having trouble. This led to the idea of possibly creating a syllabus directory that contains the syllabi for every version of the class. This could be set up by departments and then a quick search would allow students and tutors to have a brief synopsis of the course with a better understanding of how to approach the material.

Suggestions

Specific solutions we would propose to faculty in light of our focus group findings can also be sorted into the three UDL principle categories. Some suggestions come directly from the students in the focus groups, and others were tools selected seemingly fitting to topics discussed in the groups.

Engagement

- Provide schedule to students in syllabus
- Save a few minutes at the end of class for questions
- Bring in a real world application, personal story, or brief activity to help students connect what they are learning to where it is relevant in their futures
- Set up a platform for connections to be made within the class, such as the computer science discord, microsoft teams, group me, or create small groups within the class to be teams for the semester and have them set up some form of communication
- Have some sort of brief evaluation in class (poll everywhere, socrative, etc.) for students to gauge their understanding of the material, and receive instantaneous feedback on it
- Post goals and difficulty levels to help clarify the course material structure and aid in navigation for students

Expression

- Offer multimedia resources for course material: recorded lectures, drawing/visual organizations of content, pre-posted slides, lecture notes you follow, activities to prepare/reinforce class material
- Provide resources such as extra problems and review sheets similar to those seen in your course to SIUE resources such as the tutoring center
- Provide multiple options for assignments/projects, encourage innovation by developing multiple means of showcasing and exercising a skill
- Incorporate “low impact” assignments in class, for students to engage with material and showcase progress (and receive feedback), but not have their grade heavily impacted
- Include estimated time commitments to assignments/studying/projects on syllabus so students can organize time accordingly for the course’s demands

Representation

- Present expected prior knowledge at the beginning of the course, and provide resources for students to acquire the background knowledge if needed

- Incorporate flexibility into course design: Q&A style class period, provide goal setting & progress trackers for students to follow over time
- Provide practice materials and repetition work made by the professor for students to grow accustomed to your teaching style
- Provide various outlets for labs/hands on work & projects for students to apply material how it interests them/most applies to their future goals
- Provide detailed how-to's, manipulatives, and independent activities for students to access to engage material outside of class but still have guidance as they pick up on content
- Highlight main themes, goals, and connections students should be making as the course progresses (provide framework for them to then fill in misunderstanding how best works for them individually with resources provided)

Belongingness

Overall, students seemed to have a high sense of belonging in STEM education at SIUE. When asked to describe a time when they did not feel like they belonged in a STEM field, most participants could hardly think of an instance when this occurred. This proves that professors are already doing a fantastic job at making their students feel like they are meant to be here. However, there were some examples participants mentioned where they felt as though they did not belong in STEM.

The majority of students who struggled with their sense of belonging related it to a high school experience. Participants mentioned that past classmates and even teachers had belittled them for wanting to pursue STEM. Students were told they were not good enough to be successful in a STEM career. Most of these students mentioned that studying STEM education at SIUE has made them overcome these comments and made them feel more secure in their career choice. Additionally, students linked a sense of belonging to engagement in material. Some participants felt as though they did not belong in a class when they could not make any real world connections to the material they were learning in class. This made them feel as though the material did not matter and was not worth studying. They felt that if this did not matter to them then maybe a career in STEM is not right for them. Similarly, students felt a decrease in sense of belonging when professors made prior assumptions about their course knowledge. This particularly came into play with international students. Because they came from different educational backgrounds, they did not understand some of the foundational material expected of them. This made the class more difficult and affected their sense of belonging at SIUE and in a STEM career.

Based on focus group responses, many students did feel a strong sense of belonging at SIUE. Multiple participants explained how welcomed they felt by professors and the numerous faculty connections that have helped them reach their academic goals in STEM education. Students felt that STEM education at SIUE has created an inclusive environment full of instructors and peers that are willing to help them when they are struggling.

Conclusion

Student retention and success within the STEM field should be prioritized within SIUE. Listening to the voices of the students across diverse STEM classes has allowed us to see the disconnect in the areas of the application in classroom settings. Our project proposes a new and unique idea of compiling these issues into a UDL framework that could be utilized by our institution. We want to make the UDL principles known across the SIUE STEM departments, and possibly the entire university, in order for students to feel fully engaged and seen by their faculty. Multiple means of engagement correlated to how comfortable students in the focus groups felt connected to their professors, and the flexibility of office hours being important to many students. For multiple means of representation, many students don't have the same level of education when coming into the university setting, and instead of leaving them to struggle, UDL presents a way to even out the playing field and make sure those students feel like they are a part of the classroom. Finally, for multiple means of expression, students said that change needs to be made on communication between faculty and tutoring services, providing a smoother transition and learning experience for the student.

This is just the beginning of the complicated research needed to improve student success in the STEM courses at SIUE. Students all have a unique story that brings meaning to why we're studying here. We have purpose, ideas, goals, and amazing ambitions that should be encouraged by our faculty who can help guide us to said goals. When we started this project in May 2022, we set out to create a more accessible learning environment for STEM students. What we uncovered was a clear message from all students for better communication between students and faculty. As STEM Student Ambassadors, our project means more than just this document you are reading. It is the voice of students who want to succeed within SIUE, and we believe the UDL framework can help break through the barrier that prevents so many of our STEM students from continuing to pursue their educational goals. We want to invite you to consider being a part of something bigger in education, being the facilitators of the success of every student you encounter.