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The Challenge: The Role of the Student in Engineering and Technological Literacy Programs, Perspectives, Discussions, and Ideations

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Abstract

In this work, we address the role(s) students play during their education. While the students' main role is to learn, it is observed that in most classrooms, students approach learning through the lens of the instructor's vision. The authors have experienced it in engineering as well as technological literacy classes, with some differences. For this paper we focus on the engineering students. In recent years, newer pedagogical approaches and improvements in instruction techniques have expanded the student's view from this lens [1,2]. Nonetheless, students who are taking more than a few classes with heavy syllabi tend to focus on finishing the classes with reasonable performance. This is done knowing that it is not the best approach to learning. However, the students end up believing that grades are more important than deeper learning [3]. The pedagogical approaches need to have the right approach to include the students' views and voices to some degree. It is important to retain the students' autonomy and perspectives. They need to own their role as active participants of the class.

While the new pedagogical approaches increase student participation, they are yet to tap into the students' actual thoughts and learnings within the classroom (unless the classroom does active learning, and in particular includes reflective practice and various ways of engagement and sharing of perspectives). This is because students generally tend to communicate what they think the instructor expects of them, rather than their confusions and doubts. To overcome this facade, we believe that students need to be more invested in their learning environment. Inquiry-based learning with elements of reflective activities in a "safe and brave" environment is one such platform where students can communicate their progress and learning and contribute to the classroom learning environment. The instructor needs to make sure students have avenues, to be honest, share their ideas, critiques, and challenges with the instruction team. It is an approach that makes learning current for both the instructor and students. In this work, we discuss the similarities and differences between how instructors and students view the students' classroom roles and how recognizing and synthesizing these roles can eventually lead to a collaborative learning environment.

Introduction/Motivation

Engineering courses are typically structured to be systematic, content-heavy, and based on fine details and concepts. While such a course structure is thought necessary for most courses, it has been observed that students tend to gravitate towards rote learning and perhaps mostly remembering just enough to succeed in the exams [1]. There are two ways to counteract this problem. The first approach is to reduce the course content and focus on essential and important concepts in more detail, with repeated activities around the reduced number of topics [2]. The second approach is to demand more engagement from the students [2]. This method is shown to be effective as seen in prior literature [2-6]. However, it is observed that while students are more

collaborative in such dynamic learning environments, they still tend to align themselves to the views of their team, and eventually, the direction of the course is defined by the instructor. So, while the active learning approach does bring the team along in the process of learning, there are some aspects that still need to be addressed. One such aspect is the students' engagement in terms of communicating their doubts and confusions. Typically, students show their original work via assignments, quizzes, projects, and tests. However, the timeline for such activities is typically spread out. This can lead to a slowly building communication gap between the student and the instructor. In such situations, is there a possibility of obtaining real-time feedback in a classroom? Can the students play a larger role in their education beyond passively receiving and processing information from their instructors and peers? How can they be more engaged, be present, and deal with their confusions, doubts, questions, and ideas as they see new content or connect what they learn with prior knowledge? This is the premise for our research.

Expectations, Expected Role of Students: Instructors View

As an engineering educator, the basic expectation from any classroom is that students are interested, ask questions when they get stuck (or just to learn more), and engage in the process of learning. For instructors, the general attempt is to keep up with the students' learning pace by adjusting the course activities, and possibly content to the students' capabilities. At the same time, the instructor is seeking ways to communicate ideas to the students in meaningful and relatable ways. The goal of the instructor is to facilitate their learning and provide them the ability to employ these concepts in their future courses and careers. The hope is that students can learn, be engaged in the process of learning, and can adapt to what they learn as they progress in their careers.

Expectations, Expected Role of Students: Students View

As a student, the expectation is that the instructor is fair/unbiased and can take the time to listen and provide feedback. The instructor should make effective use of class time and convey topics in a manner that is easy to understand. The instructors are "expected" to be conscious of the time commitment needed from students and assign work that effectively and accurately helps the students learn, without being overly time-consuming or burdensome [7].

Students want to be successful in the exams (as that is the most used measure of knowledge that is available) and students are willing to go the extra mile in learning as long as the instructor can highlight key topics and ideas of interest. They are hopeful that what they learn helps in obtaining a position in the workforce. Students want to understand concepts well and do their best in being attentive and receptive to knowledge in the classroom. They also put in an honest effort into their coursework and seek practical ways to finish what is needed of them.

It seems that life as a student is devoted to attending class, completing assignments, and being successful in the assignments, tests, laboratories, etc. While these are all necessary to help track learning and growth, students' future/success seem to be determined by how the classes are graded, rather than the material learned. Most classes are viewed as competitive spaces, and students need to perform better than their peers in order to be in the upper percentiles of the classes. Students believe that their grades and success in the classes have a direct correlation to the type of jobs they acquire [8-10]. In addition, the majority of employers who visit campuses for interviewing students

tend to filter students based on high Grade Point Averages (GPA). In interviews with students, and the student placement office, it is clear that students with lower GPA's have fewer chances to be interviewed and or be offered a position.

Mutual Expectations

Based on the two prior views, it is understood that both the instructor and the students treat the classroom as a space of mutual interactions, with the arrow of information flowing from the instructor to the student, and with the hope of learning and growth. The students are willing to put in an honest effort into their work as long as they can obtain some guaranteed results. Meanwhile, the faculty are invested in clarifying and instructing students to their best abilities. They want to be available to the students and help them be successful in their upcoming courses and careers. Maybe, there needs to be a focus on changing the language. The expectation is for one to INSTRUCT and the other to LEARN. In many cases, the new pedagogical approaches are focusing on facilitation and engagement that results in a dialog, and multilogue between the educator and the students, and most importantly, between students and students. While this is changing gradually, there are still a good number of faculty who are using the traditional ways of teaching, especially in higher level classes, where the material is more "important" in specialized fields.

Avenues for Improvement

There are many processes and methodologies that have been successfully proposed, tested, and examined. They all include providing more active participation to the students [5 - 7]. The goal has been to help students to move from passive learners to active engaged learners and participants [11 - 14]. At the same time, we also hope that the students can find the instructors to be more accessible and can view them as a stakeholder invested in their learning [15].

While the message of learning resounds in the views of the instructors and the students, we find that in reality, the implementation shows some mismatch in our present-day classrooms. In order to address this, we want to change the classroom dynamics by bringing in a form of active inquiry [2]. The ideology behind this course is inspired by John Dewey's work on inquiry-based learning. The ideology is that every student begins the process of learning once they encounter a problem and then uses a few steps to seek and search ways by examining the knowledge, interconnections, and experimentation to not only solve the problem but also make better emancipation, finding conceptual and practical relationships to address next class of problems and challenges.

This process is well described in prior literature [2, 16] and we have used these principles to design many of our courses. Our goal is to ensure that while students are going through their personalized inquiry process, they can engage with their peers and communicate their status with the instructors. This form of feedback can make the students play a significant role in their classroom education and enhance the course outcomes.

The student's Autonomy: Student as an agent of change

The instructor's goal should be facilitating students' learning, providing a creative space for encouraging engagement, discussions, and moving towards more in-depth and advanced learning, problem finding, and problem-solving. At the same time, students need to be more than just passive participants, expecting to have a one-directional pathway to knowledge. Students and faculty need to have reflections, discussions, open Q/A, and examination of the expectations several times during the process. Students need to be honest, responsible, and provide a clear perspective of what is working and what is not. They need to use the process of inquiry to learn and find better ways to be engaged and facilitate their learning throughout the class development process. The autonomy assumes that they are as much of the owner and responsible partners in the class as the educator and teaching assistants [17, 18].

Autonomy can be achieved by students actively taking the lead and owning their learning. The students should keep working to be better critical thinkers. Students need to find ways that they can be more effective and provide suggestions and ideas for the betterment of the class culture, learning environment, and engagement. They should be allowed and encouraged to have reflections, discussions, and meetings with the instruction team. A crucial element towards facilitating student reflection and communication with the instruction team is establishing trust in the classroom. Once trust is established, students feel their feedback is valued and they can express it without hesitation [18].

What does this mean in action? An inquiry process that students are going to be engaged in. The faculty need to address the students' habits, processes of dealing with the material, problem-solving, and examinations of the weakness of their actions as well as avenues to improve it with the instructor's participation. It is not solely to the benefit of one student, but the benefit of all engaged that is to be addressed. A critical analysis of what is working and what is not can help clarify the roles of the faculty and the students are in this process.

Of course, providing autonomy and responsibility to the students will not be the most efficient way to cover a huge amount of material in the class. The solution is not to make it harder to filter the weak students or make it easier to quiet the students' concerns. The goal is to have an environment where the students think about their learning, can make meaningful connections to other classes and previous knowledge, and value what they learn, what they connect, and how they learn. Considering the amount of effort faculty and students invest into the process of learning, a few additional steps described in this work can make the learning/teaching process enriching for both the instructor and the students.

Conclusions

In this paper, we discuss the disparity between the expectations and reality of students in classrooms. Our observations show that student learning is impacted by the threat of grades, fear of being singled out, and future career prospects. At the same time, the presence of minimal communication and a delayed feedback cycle between the instructor and the students leads to learning voids in the students' minds. We show that by assigning more responsibility (autonomy) to the students, asking them to be more engaged, and real-time feedback (as in inquiry classrooms) the student can play a significant role in enhancing their classroom learning experience.

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