

Learning in Transition: Developing and Employing Pedagogical Supports to Enhance Student Learning in Engineering Education

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Scholarly research indicates that classroom environment and conditions influence the degree of student learning, levels of engagement, and overall success in engineering education. In the wake of COVID-19, educational institutions transitioned to fully online delivery that disrupted traditional and effective channels of communication enacted in classroom contexts. For a substantial number of faculty members, this rapid transition to a fully remote instructional context marked the start a novel style of teaching and learning environment, a grand departure from the traditional, direct face-to-face setting. Such rapid and disruptive change required creative solutions to routinized instructional practices and compelling faculty to adjust and/or adopt various communication strategies to address challenges such as the lack of academic resources, and established campus practices that promote effective learning. Over the last two years, researchers have engaged in numerous studies to learn more about how this transition has impacted both teaching and learning in higher education. In this study, students enrolled two engineering courses in a public, minority-serving institution in Texas, were surveyed to understand their academic experiences during the period of remote instruction and provide valuable insight and assistance to identify pedagogical strengths as well as areas of opportunities for faculty members who are or will be offering online courses. The survey particularly focused on capturing various instructional and pedagogical supports and approaches such as course expectations, lecture format, assignments, office hours, and student accommodations. Results indicate that faculty members were effectively able to encourage students to contact them if they had questions regarding coursework and assignments. Similarly, seventy-six percent of students reported that their instructors were receptive to their learning needs. At a microlevel, however, the data revealed certain areas in which instructors can make efforts to enhance current communication and instructional practices. One was the consistency for faculty to effectively communicate course expectations. Specifically, twenty-two percent of the participants mentioned the instructor did not clearly communicate course expectations during remote instruction.

I. BACKGROUND AND MOTIVATION

Background

According to ongoing research efforts, classroom environment, which alludes to the tone, climate, or ambience influencing the setting, has a profuse impact on student engagement, success, and learning in engineering education [1], [2], [3], [4], [5]. It is reported that educational productivity and success depends on the psychosocial aspect of the classroom, which is a combination of psychological factors and the social environment [6], [7], [8], [9], [10], [11], [12]. For this reason, faculty members are bestowed the responsibility of preparing and disseminating lecture content with clarity and technical structure such that it creates a climate that engages diverse learning styles and stimulates academic development [2].

Several communication models/strategies have been designed and implemented with the intention of addressing the psychosocial aspect of the classroom [2], [3], [6], [7], [8], many of which have rendered immediate and long-term benefits. For instance, a model termed ECNQ (acronym for Engage, Communicate, Names, Questions) was designed and implemented as an active and dynamic approach to 1) engage students in the engineering classroom, and 2) disrupt traditional

teaching practices [14]. Particularly, the ECNQ model establishes four communication strategies that eliminate intimidation barriers and foster an intellectually rich and healthy environment: 1) verbally encourage student participation during lecture sessions, 2) communicate with students before and after class, 3) learn student names, and 4) pose non-intuitive questions to spark curiosity [2].

According to the model, it is necessary – as an initiative from faculty members – to encourage student participation during lectures which is an approach intended to eliminate intimidation barriers. It is further suggested that faculty instructors establish a consistent rapport with students before and after class such that a climate that impacts learning, engagement, and success is fabricated [14]. An additional channel of communication that is proposed in the ECNQ model is learning and referencing student names during or outside the lecture hall to establish a sense of community and bond with the class. As evidenced by the study, the four communication strategies minimize traditional classroom power relations, strengthens student-instructor communication, increases student collaboration, and fosters an active learning environment which promotes student engagement and learning [2].

However, since the emergence of COVID-19, in which in-person instruction momentarily transitioned to online modality, faculty instructors have been on a transitional period modifying conventional communication methods for purposes of enhancing students' engagement, comprehension, and scholarship abilities [3]. For a substantial number of faculty members, this rapid transition to a fully remote instructional context marked the start a novel style of teaching and learning environment, a grand departure from the traditional, direct face-to-face setting. Such rapid and disruptive change required creative solutions to routinized instructional practices and compelling faculty to adjust and/or adopt various communication strategies to address challenges such as the lack of academic resources, and established campus practices that promote effective learning. To address such pedagogical and academic factors, Marquez and Garcia developed and implemented a model termed CIRE (e.g., acronym for Communication, Initiation, Reduction, and Extension), in which an instructional template was recommended for online instruction [15].

The model consists of incorporating four major pedagogical strategies: 1) constant communication, 2) initiating homework problems during the lecture, 3) reducing the number of problems on homework and exams, and 4) granting extensions on homework assignments [3]. According to the model's first component, a communication strategy was consistently established with the students via email and CANVAS portal to ease the transition from in-person instruction to online learning and consequently eliminate the amount of confusion transpiring in a very short period of time [3]. During the online instructional period, constant communication was maintained regarding curricular modifications such as class structure, grading policies, office hours, homework/exam format, submission policies, and extension on assignments. The study reveals a positive level of student satisfaction with the clear, consistent, and adequate communication strategy implemented by the instructor [3].

Motivation of Study

The motivation for the study is three-fold: (1) to gain a deeper understanding of engineering students' experiences during COVID-19; (2) identify strengths and opportunities for growth for engineering faculty; and (3) provide practical tools and strategies that help enhance faculty effectiveness. Though various communication models have generated favorable outcomes such as fostering student-instructor interaction, student collaboration, and establishing active learning

environments, oftentimes roadblocks hinder effective communication between faculty members and students. Faculty members tend to attribute such disconnection to the lack of student engagement, while students tend to blame their academic challenges on faculty members. Through a faculty context, a major roadblock that has generated disengagement during lectures for a plethora of students is the complications surrounding COVID-19. This lack of engagement has emerged from predicaments such as online instruction, family distress, lack of resources during online instruction, well-being issues, etc.

From a students' perspective, several barriers that hinder effective communication during in-person or online instruction include the absence of a well-structured curriculum, insufficient motivation to disseminate content, lack of clarification on abstract topics, or even unwillingness to establish communication channels outside the classroom. In other instances, communication vanishes when lecture sessions at the undergraduate level periodically drift to research themes rather than consolidating fundamental engineering principles [2]. When such wandering transpires, students tend to disengage and abstain from participating during lectures due to the abstract technical content presented outside their level of understanding.

II. PURPOSE OF RESEARCH

Research efforts have examined the effects of the COVID-19 pandemic imposed on traditional modes of teaching and learning. Nascent research in this area has emphasized the critical need of establishing effective modes and channels of communication between faculty and students. Moreover, research has indicated the importance of developing effective approaches that help create a sense of community and collaboration among students engaged in a shared virtual/remote learning context. It is in this context in which this study is situated and attempts to add to this emerging body of research.

In this research study, the authors aim to understand academic experiences during the period of remote instruction that would provide value assistance to faculty members in identifying pedagogical strengths and provide areas of opportunities for those who are or will be offering online courses. Given the variability of instructional methods implemented during online learning, many which have not been reported in the literature, it is important to identify current creative teaching practices which will assist faculty members in creating solutions to routinized instructional practices.

To contextualize the research effort, the authors utilize a social constructivist theory to guide the research and meaning making process. Social constructivist theory posits that knowledge is actively constructed by individuals through engagement in different social settings and interactions [7]. This perspective on knowledge views the learners as active participants in the learning process and positions educators as facilitators to create the conditions that support and nurture inquiry, relationships, and collaboration.

The proposed work was intended to understand the following communication aspects between faculty and students:

Aspect 1: Overall effectiveness of instructors' ability to communicate course expectations and other related topics to the students

The intention is to identify the instructors' effectiveness to communicate course expectations during the period of remote instruction. This implies curriculum aspects such as office hours, homework submission, deadlines, extensions, or accommodations. This communication aspect could effectuate through various mediums such as email, online portals (e.g., Blackboard, CANVAS, etc.), or during lecture sessions.

Aspect 2: Promptness of instructors' communication

For this aspect, it is critical to understand the promptness of the instructors' communication with students, particularly when announcing important dates, changes in the curriculum structure, or simply replying to an email. It is believed that the promptness of communication may serve as a way for students to remain engaged during the course (e.g., attendance to lectures, office hours, participating in class, etc.).

Aspect 3: Encouragement students received from faculty to contact them regarding course related queries

In this regard, it is important to study the ability for faculty members to motivate communication with students, in particular, pertaining to office hours or course related questions. This specific aspect is paramount since it can give insight on the never-ending staggering attendance to office hours, or participation during lecture sessions.

Aspect 4: Instructors' receptiveness to needs and accommodations related to remote learning

As a result of COVID-19, students lacking resources at home have created additional problems for faculty members. Several which involve attending lectures, recitation sessions, staying engaged, or submitting assignments on time. As such, many students required some sort of accommodations to alleviate predicaments such as family distress, lack of resources during online instruction, well-being issues, etc. This communication aspect is intended to gauge the faculty's receptivity to unexpected situations.

Aspect 5: Frequency by which student communicated with faculty members regarding accommodations, assignments, or coursework

It is equally important to understand whether students initiated communication with faculty members when needing accommodations. Frequently, faculty members are unaware of the adversity experienced by students during the semester. It is not only the responsibility for faculty members to be flexible in certain situations, but it is also the responsibility of students to reach out when needed. This specific aspect is critical as it will give insight on the barriers that students, particularly at Minority Serving Institutions, create on themselves.

Aspect 6: Consideration of instructor when sought assistance during online learning

It will be necessary to understand whether the instructor deemed appropriate to grant accommodations when petitioned by students. There might be instances when the

instructor is flexible, and there could be instances where the instructor denied the petition.

Aspect 7: Completing assignments in a timely manner

In this context, it is important to understand whether students were able to complete their assignments in a timely manner during the period of online instruction. Given the unforeseen circumstances surrounding the pandemic, there might have been students that completed assignments on time, and students who did not. It is essential to further understand the factors that hinder on-time submission. This will provide a better perspective in understanding the challenges that are experienced by students in underserved communities.

Correlation of Study with Overall Research Objective

This research study adds to the nascent research of exploring rapid responses by faculty to address issues associated with remote instruction and document effective instructional practices. It further stems from the long-term research objective of the authors which is to increase retention rates in engineering education, enhance academic preparation, and to increase the number of minorities in STEM fields and graduate school (Figure 1). These research objectives are believed to be attained by identifying, designing, and implementing effective pedagogical methods that will be communicated with engineering faculty who are unfamiliar with effective instructional practices. The objective is for engineering faculty members to incorporate any of the recommended practices to enhance student engagement, comprehension, and scholarship abilities.

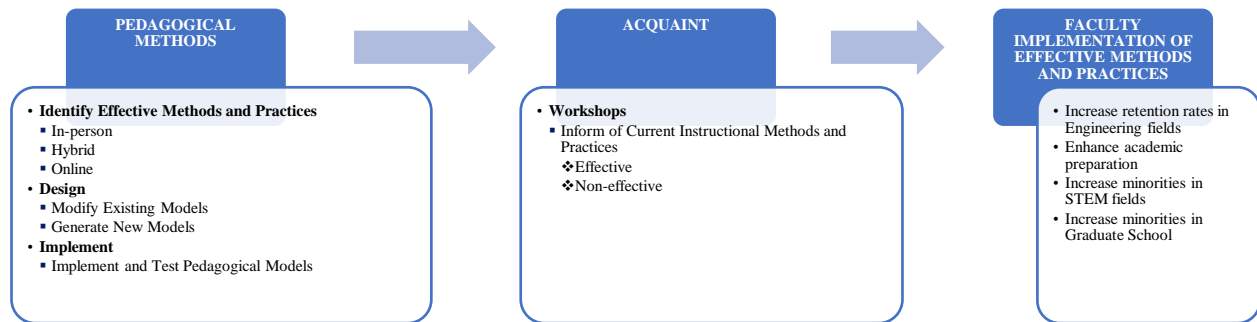


Figure 1. Long-term Research Objective

III. METHODS AND ANALYSIS

For this study, a total of thirty-four students enrolled two engineering courses at The University of Texas Rio Grande Valley were surveyed to understand their academic experiences during the period of remote instruction and provide valuable insight and assistance to identify pedagogical strengths and as well as areas of opportunities for faculty members who are or will be offering online courses. The survey particularly focused on capturing various instructional and pedagogical

supports and approaches such as course expectations, lecture format, assignments, office hours, and student accommodations. The survey was administered to sophomores and juniors pursuing Mechanical Engineering at the end of the semester, which were invited orally during class and via email. Participant demographics consisted of eight females and twenty-six males (Table 1). Of those participants, 8% identified as White, 85% identified as Hispanic, and 7% identified as International.

In this context, a small, self-developed survey was generated as the primary data collection method, in which questions were intended to understand classroom experiences during the period of remote instruction. It is noted that descriptive statistics were employed for analysis and presentation of data results.

Limitations of the Study

As previously mentioned, the self-developed survey was developed to ensure that students had the opportunity to share about the experiences during a very difficult period during their academic journeys. Students' anonymities were honored during the process which provided the opportunity to share freely and candidly about their experiences. Due to the nature of the study, research design, and context, the authors identified the following limitations: (a) small sample size; (b) self-developed survey instrument; (c) convenient sampling procedure.

Although students enrolled in this course were provided the same survey, the authors are keenly aware of factors that impact students learning experiences, particularly individual learning styles and learning needs. The survey did not require students to list their preferred way of learning and did not invite them to disclose specific impediments to learning. Future research in this area may benefit from including such information and will be a topic of high priority.

Table 1. Student Demographics

Variable	Total	Percentage
Gender		
<i>Females</i>	8	24%
<i>Males</i>	26	76%
Race/Ethnicity		
<i>White</i>	3	8%
<i>Hispanic</i>	29	85%
<i>International</i>	2	7%

The administered survey consisted of ten questions:

Question 1: During the period of online instruction, did your instructors effectively communicate their course expectations? This includes: lecture format, attendance to online lectures, meeting time, office hours, assignments, accommodations, etc.

Question 2: Out of 4 of your instructors during the transition to online instruction, how many would you say communicated effectively their course expectations for remote instruction?

Question 3: During the period of online instruction, did your instructors communicate in a timely fashion?

Question 4: During online instruction, were you encouraged by you instructors to contact them if students had questions?

Question 5: Based on your experience during remote instruction, were instructors receptive to student needs and accommodations?

Question 6: During online instruction, did you contact your instructors asking for accommodations (e.g., additional time) on assignments?

Question 7: During online instruction, how many times did you contact your instructor, via email, if you had questions on assignments?

Question 8: How helpful was your instructor when you sought assistance during online learning?

Question 9: During online learning, did you find it difficult to submit assignments on time?

Question 10: How do you feel about the professor's communication regarding HW assignments, class updates, or announcements via email/CANVAS or Zoom

IV. RESULTS & DISSCUSSION

Findings

To assist with data analysis, the authors categorized the data into two broad themes: communication strengths of faculty and opportunities for growth for faculty. These two distinct yet important themes help to distinguish areas in which faculty demonstrated effective communication with students and opportunities to enhance current communication practices. The authors note that given the sample size, the recommendations provided are not intended to be all encompassing nor generalizable to all faculty. The intention is to offer potentially useful suggestions that can be modified, adapted, and applied to respective learning contexts.

Communication Strengths – Data Analysis

By looking at the data, it became clear that based on the students surveyed in the study, faculty members did a solid job to encourage students to contact them if they had questions regarding coursework and assignments. Moreover, a large percentage of students reported that their instructors were receptive to their learning needs, though the paper does not dive deeply into this arena. This finding is relevant due to the disruption of normative learning and communication

practices both students and faculty were accustomed to. Drawing from this data, we may consider the fact that faculty were aware of students' needs and made deliberate efforts to accommodate instruction when needed. Additionally, most students agreed that their instructors encouraged them to communicate any course related issues or queries. Such positive messaging and reassurance from faculty can positively reduce students' hesitancy or anxiety to contact faculty regarding coursework.

Opportunities for Growth – Data Analysis

An important part of the institutional culture of higher education is the necessity to refine, strengthen, and enhance existing processes, practices, and policies to ensure the academic success of students. Based on the data collected, several implications for university personnel, educational researchers, and other institutional partners. First, at a broader level, this study and its results can help inform institutional administration to invest in creating professional development opportunities for engineering faculty. University leaders are tasked with ensuring faculty effectiveness and this can be achieved by providing high quality, professional learning materials and experiences for teaching faculty. The creation and implementation of courses that address the importance of effective communication in a hybrid learning context can greatly strengthen faculty members' ability to realize instructional and program goals. One recommendation is to develop a strategic plan that responds to the needs of engineering faculty. This plan can encompass professional development sessions, the creation of asynchronous learning modules, guest lectures by leading experts in the field, and other online resources. Moreover, College of Engineering leadership can embrace an interdisciplinary approach by collaborating with personnel from different colleges such as those from education, communications, and technology to develop robust learning experiences for engineering faculty.

At a microlevel, the data revealed certain areas in which instructors can make efforts to enhance current communication and instructional practices. One area that might be of interest to instructors is the consistency for all faculty and instructors to effectively communicate course expectations. Although data revealed that most students believed their instructors communicated course expectations effectively, under 10% of students believed that all four of their instructors achieved this goal. Thus, it might benefit instructors to think deeply about how they are relaying course expectations and if students fully understand their responsibilities as learners.

Given the challenges presented by hybrid/remote instruction, faculty members must be mindful of students' diverse communication needs and must consider methods to engage all students effectively. Assumptions about how students learn and communicate can be easily made and therefore, engineering faculty would be wise to make deliberate and intentional efforts to learn more about student needs and learning contexts. This will greatly help establish a learning culture that invites student feedback and encourages collective participation and engagement.

Another interesting finding centered on students' confidence in contacting their instructors to request accommodations to assist in understanding course materials. Data revealed that more than half of the students reported that they indeed request certain modifications and/or accommodations. On the other hand, those who did not shared that they were either intimidated or did not want to give the impression that they were struggling with course material. This finding is critical for all instructors to consider as it reveals that many students prefer to suffer in silence as opposed to having the confidence or reassurance to ask questions without the fear of being

disparaged or deemed as unfit to participate in the course. As such, these findings can assist faculty in creating effective systems of communication and an environment conducive to communicating concerns. Below illustrate several student responses:

“Good! Kept us up to date, responsive to questions/concerns. A few small moments of confusion here and there, but nothing that couldn't be easily cleared up or worked around.”

“Communication was great and deadlines were very clear and doable. The deadlines allowed enough time for all assignments but also did not allow for idleness and lack of challenges in the course.”

“I feel the instructor did great in this aspect. However, being a student who wasn't able to join class live and had to watch the zoom recordings, I was sometimes a little late to hearing the announcements that were only given on zoom. Overall, though, it was a great experience.”

“Overall, the communication was very good. There were a few times where the exam or homework due dates/times were unclear or inconsistent, but I think sharing announcements at the beginning of class and by email were very useful.”

“I thought the class was really well organized and easy to follow! The assignments helped us practice for the exam! And the updates and files posted on canvas were easy to find.”

“Overall, it was great. My only comment is that sometimes the times at which the homeworks were due were not made completely clear in lecture, and the assignments for the homeworks wouldn't appear until midnight the night before the HW was due, which made it a bit stressful (this only happened like 2 or 3 times so it wasn't something major). As for the rest of the course, the instructor did a really great job reminding us of the day when HWs would be due and when we would have our exams.”

Question 1: *During the period of online instruction, did your instructors effectively communicate their course expectations? This includes following: lecture format, attendance to online lectures, meeting time, office hours, assignments, accommodations, etc.*

Question 2: *Out of 4 of your instructors during the transition to online instruction, how many would you say communicated effectively their course expectations for remote instruction?*

Questions 1 and 2 were related to the overall effectiveness of instructors' ability to communicate course expectations and other related topics to the students. Over half of the students (51.5%) reported that their instructors effectively communicated their course expectations, while 21.2% indicated that their instructors successfully communicated expectations about half the time. Moreover, 18.2% of students reported that their instructors communicated course expectations effectively sometimes. For question 2, most students (42.4%) indicated that at least half of their

instructors (2 out of 4) effectively communicated course expectations, compared to only 9.1% who specified that all four faculty members met this criterion.

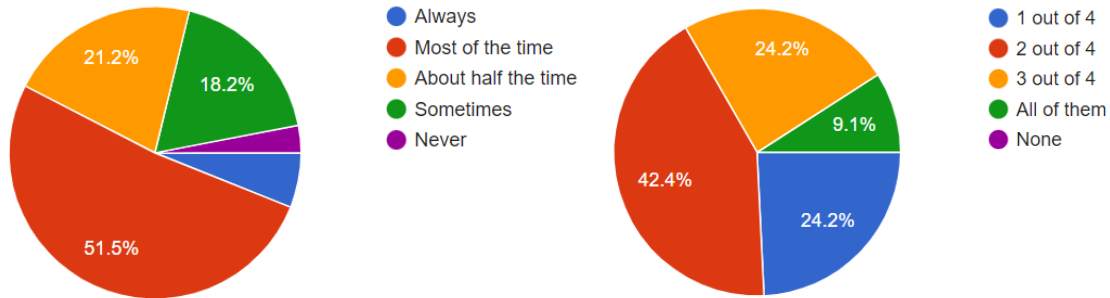


Figure 1. Effectiveness to Communicate – Questions 1 and 2

Question 3 asked students about the promptness of their instructors' communication. Roughly (60%) of the students reported that their instructors communicated in a timely fashion almost always or most of the time. About a quarter (24.2%) of the students reported they received timely communication from their instructors at least half of the time.

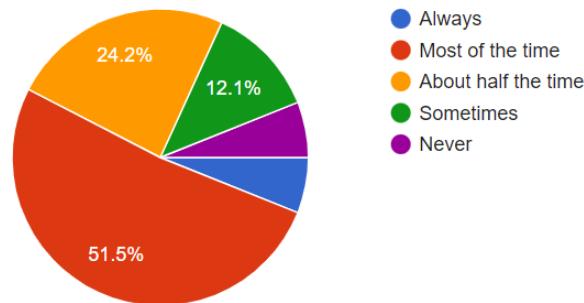


Figure 2. Promptness to Communicate – Question 3

On Question 4, most students (72.8%) indicated favorable results regarding encouragement they received from faculty to contact them regarding course related queries. Only 15.2% of the students reported partial encouragement from their instructors to reach out to address questions related to the course.

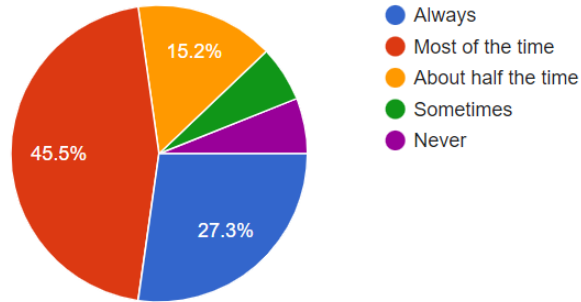


Figure 3. Students Encouraged by Faculty to Contact Them – Question 4

On Question 5, 76.6% of the students reported that their instructors were highly receptive to needs and accommodations related to remote learning.

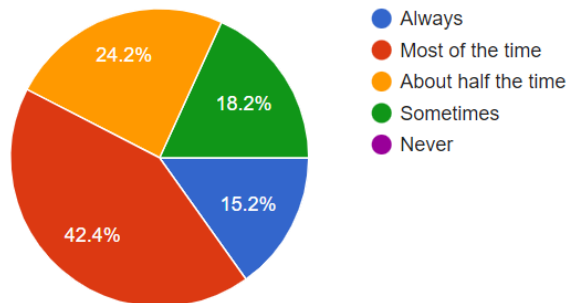


Figure 4: Receptive to Needs and Accommodations – Question 5

Several questions were posed to students to gauge the frequency and theme with which they communicated with faculty members. Specifically, Question 6 asked “Did you contact your instructors asking for accommodations (e.g., additional time) on assignments?” Nearly 61% of the students indicated they asked their instructors for accommodations on assignments. One interesting finding is that students who did not ask for accommodations noted that they did not want to reveal that they were struggling with course material. Others shared that they felt intimidated and therefore did not contact their instructors to request any accommodations.

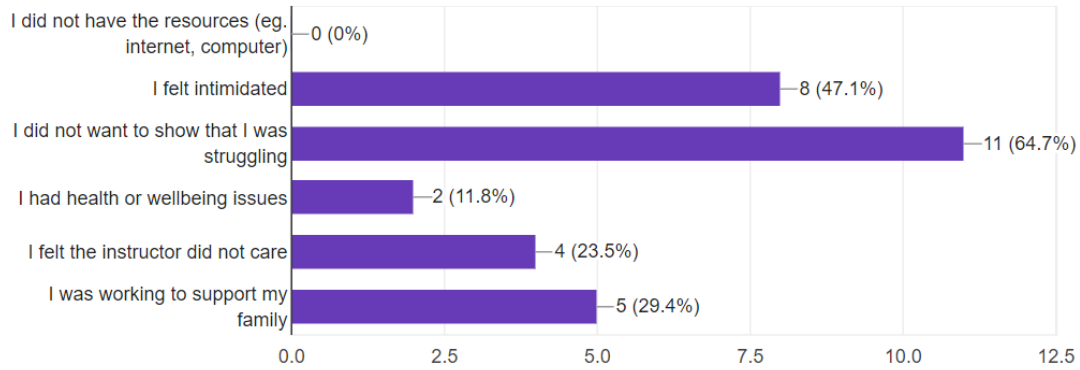


Figure 5. Contacting Faculty for Accommodations on Assignments – Question 6

Question 7 asked students about the frequency with which they contacted their instructor regarding questions on assignments and coursework. Nearly 70% of the students indicated that they contacted/mailed their instructors at least once during the semester, while 18.2% of the respondents contacted/mailed more than six times.

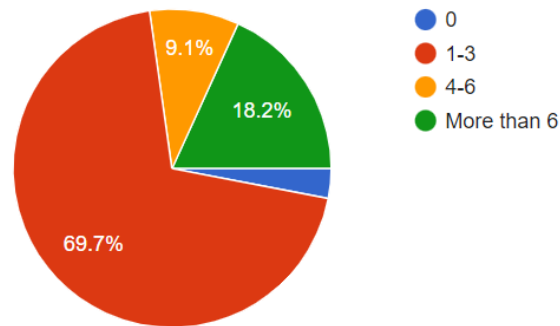


Figure 6. Frequency Used to Contact Instructors Regarding Assignments – Question 7

Question 8 asked, “How helpful was your instructor when you sought assistance during online learning?” In this case, 18.2% reported that their instructors were ‘very helpful’, while nearly 80% conveyed that their instructors were ‘somewhat helpful.’

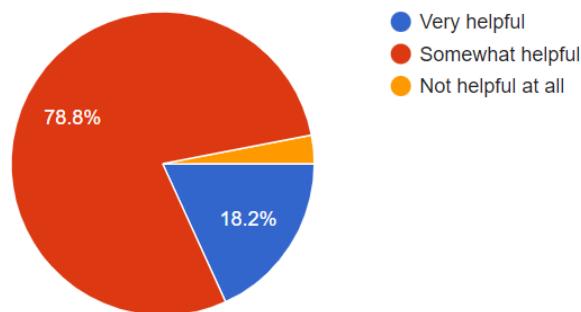


Figure 7. Helpful When Needed – Question 8

Question 9 sought to understand students' ability to complete assignments in a timely manner. Two-thirds (66.7%) of the students reported that they found it difficult to complete and submit their assignments on time. The data further revealed there are numerous factors that work to impede students' ability to complete coursework by the prescribed date of submission. Nearly 80% of the students indicated that they found it difficult to exercise the concentration required to complete assignments. Additionally, difficulty in managing multiple responsibilities (72.7%) and having to watch the lecture videos (72.7%) were other factors that contributed to barriers to submitting coursework on time. Moreover, roughly half of the students reported having family related issues as significant challenges to submitting assignments in a timely manner.

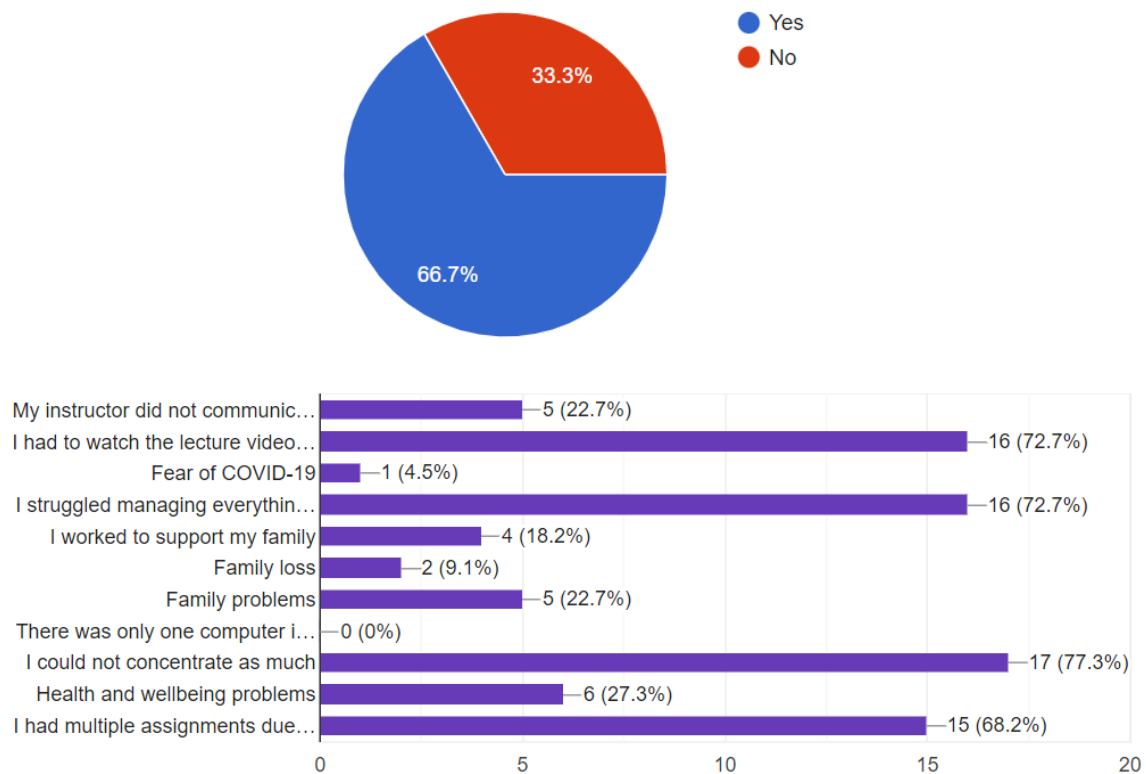


Figure 8. Completing Assignment on Time – Question 9

The last question was an open-ended item that afforded the opportunity to share thoughts the instructor's communication regarding course-related information and tasks (i.e., assignments, class updates, or announcements via email/CANVAS or Zoom).

V. CONCLUSION

The onset Covid-19 fundamentally changed traditional teaching and learning contexts and challenged faculty to develop novel solutions to respond to a new learning environment. A key aspect in adjusting to remote instruction was the development of channels for effective communication with students. In this study, the authors surveyed students enrolled two engineering courses in a public, minority-serving institution in Texas, to understand their academic

experiences during the period of remote instruction. The intention is to provide valuable insight and assistance in identifying communication strengths and opportunities for growth for faculty members teaching remotely. A survey of ten questions were administered to students to better understand their academic experiences during the period of remote instruction. Data analysis consisted of categorizing data into two broad themes: communication strengths of faculty and opportunities for growth for faculty. These two distinct yet important themes helped to distinguish areas in which faculty demonstrated effective communication with students and opportunities to enhance current communication practices. Communication strengths included: encouragement to be contacted regarding questions on coursework, receptive to student learning needs, and frequency of communication with students. Opportunities for growth included: increased efforts to effectively communicate course expectations and identifying issues that might be affecting students' ability to excel in the course. Future work will dive further into this domain by surveying faculty regarding their experiences with remote instruction and strategies to effectively engage students.

This research study adds to the nascent research of exploring rapid responses by faculty to address issues associated with remote instruction and document effective instructional practices. It further stems from the overall research objective of the authors which is to increase retention rates in engineering education, enhance academic preparation, and to increase the number of minorities in STEM fields and graduate school. It is important to note that the recommendations generated from the study are not intended to be firmly established practices but are provided as considerations and suggestions that may be useful for faculty seeking to understand more about the nuances of hybrid learning. The information drawn from the study are topics that can be utilized to engage in an ongoing dialogue about how to best serve students in various contexts. These research objectives are believed to be attained by identifying, designing, and implementing effective pedagogical methods that will be communicated with engineering faculty who are unfamiliar with effective instructional practices. The objective is for engineering faculty members to incorporate any of the recommended practices to enhance student engagement, comprehension, and scholarship abilities. With these results, the authors are in the process of organizing several internal workshops to communicate the results with the engineering faculty.

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