# The Concerns and Perceived Challenges that Students Faced When Traditional In-person Engineering Courses Suddenly Transitioned to Remote Learning

**Abstract**

This research evaluates the impact of switching college engineering courses from in-person instruction to emergency remote learning among engineering students at a university in the Midwest. The study aimed to answer the question: What were the concerns and perceived challenges students faced when traditional in-person engineering courses suddenly transitioned to remote learning? The goal of this study is to uncover the challenges students were facing in engineering online courses and to understand students' concerns. Our findings can help improve teaching instruction to provide students with previously unavailable educational assistance for online engineering courses.

We collected online survey responses during weeks 8 and 9 of the academic semester, shortly after the COVID-19 shutdown and emergency transition to remote learning in Spring 2020. The survey included two open-ended questions which inquired about students' feedback about moving the class online, and one two-item scale which assessed students' confidence in online engineering learning. Data analysis for the open-ended questions was guided by the theoretical framework - Social Cognitive Career Theory [1] that explores how context, person factors and social cognitions contribute to career goals, interests and actions. A phenomenological approach [2] was conducted to understand the experience of these students. Open coding and axial coding [2] methods were used to create initial categories then themes related to students' concerns and challenges. Data from the two-item scale was evaluated using descriptive statistics: means, standard deviations, and ranges.

Four main themes with separate sub-categories emerged from the student responses: 1) Instructor's ability to teach course online (Instructional limitations, Seeking help, Increased Workload), 2) Student's ability to learn online (Time Management, Lower engagement and motivation, Harder to absorb material, Hard to focus, Worry about performance), 3) Difficulties outside of class (Technology issues), and  4) No concerns.  Students seemed more concerned about their ability to learn the material (48% of responses) than the instructor's ability to teach the material (36% of responses).  The instructional limitations or lack of instructional support (22% of responses) and time management (12% of responses) were among the major concerns in the sub-categories.

The results from two-item scale indicated participants' s confidence in their ability to master their classroom knowledge was at an intermediate level via online instruction (6/10), and participants' confidence in the instructor's ability to teach knowledge in online classes is moderate to high (7/10). The results align with the open-ended question response in which students were somewhat more concerned about their ability to learn than the instructor's ability to teach.  The themes and analysis will be a valuable tool to help institutions and instructors improve student learning experiences.

**Introduction**

The COVID-19 pandemic in Spring 2020 had an enormous impact on education in the United States. Before the spread of COVID-19, online courses were optional to most students. However, during the pandemic, almost all courses were shifted from traditional in-person courses to emergency remote instruction, and this includes courses in engineering programs.

Although many studies provided evidence to demonstrate no significant differences in learning performance between online and on-campus engineering students regarding test scores [3]-[4], other types of difficulties were present.

Students and instructors faced challenges during online learning [5]-[6]. For example, in face-to-face classes, instructors are provided classroom, computer, markers and whiteboard and video or audio equipment. However, some instructors did not have necessary technological equipment to conduct online courses at the start of remote learning. Moreover, instructors had to re-design courses to adapt for the online learning environments. Many activities that worked well in-person had to be shifted or modified to work online. For students, they faced challenges ranging from time management, self-motivation, self-discipline, and academic integrity. Chhetri [7] completed a study to explain the challenges students experienced as the instruction model changed to remote. These challenges included deadlines and due dates, distractions, group work, hands-on activities and demos, interactions, motivations, self-learning and staying on track. Bourne, Harris, and Mayadas [8] described several challenges that online courses in engineering encountered. For example, engineering courses based on science and mathematics were traditionally the most difficult to teach online due to the need for equation manipulation. In addition, hands-on activities in laboratories were constrained. Although lab courses could be offered through a virtual reality environment, this technology was still in its early stages and not every student could readily access it.

Our study seeks to further understand the challenges that students faced in remote learning. Particularly, we sought to understand the student concerns and perceived challenges when traditional off-line engineering courses switched to online suddenly.

In order to achieve our goals, the team evaluated the impact of switching college of engineering courses from in-person instruction to remote learning for engineering students at a university in the Midwest. The current study sought to answer the question: *What were the concerns and perceived challenges students faced when traditional in-person engineering courses suddenly transitioned to remote learning?* Our findings can help improve teaching instructions to provide students with previously unavailable assistance for online engineering courses.

**Method**

*Research Design*

This study was part of an ongoing study that included a faculty learning community consisting of 8 engineering faculty members who taught required courses. To investigate the impact of the COVID-19 shutdown the research team administered an additional survey to collect data on students' experiences in the switch to online shortly after the shut-down during weeks 8 and 9 of the academic semester. Table 1 describes the general information about the 8 courses. Each set

of surveys included two open-ended questions regarding students' concerns about online course instruction and the challenges students faced. Additionally, a brief scale composed of two items was incorporated in each survey.

**Table 1: Course Descriptions**

| Course Number | Course Level /Department | Instructional Model after Transition | Instructor level | Enroll-ment | Survey responses |
|---|---|---|---|---|---|
| 1 | So. -Engr. | Sync. | Asst. Prof | 129 | 107 |
| 2 | Jr.-Civil | Sync. | Asst. Prof | 31 | 28 |
| 3 | Jr.- Mech. | Async. | Prof. | 22 | 3 |
| 4 | So.-Info. Tech. | Async. | NTT | 39 | 3 |
| 5 | Jr.-Chemical | Async. | Assoc. Prof | 25 | 14 |
| 6 | Jr.-Industrial | Async. | Asst. Prof | 35 | 5 |
| 7 | Sr.-Chemical | Async. | Prof. | 14 | 5 |
| 8 | Jr. Civil | Sync. | NTT | 31 | 23 |

*Data Collection and Instruments*

The survey instrument was constructed as follows:

1. *Open-Ended Questions* - Two open-ended questionnaires inquired about students' feedback about moving the class online. The two questions included 1) What concerns do you have about moving this class online? 2) What challenges do you anticipate encountering in online learning in this class?
2. *Two-Item Scale* - We assessed students' confidence in online engineering education with a scale that included two items. Participants responded using a 10-point Likert scale, ranging from "No Confidence at All" (0) to "Complete Confidence" (9). The two items were: 1) How confident are you in your ability to learn the material in this class via online instruction? and 2) How confident are you in your instructor's ability to teach the material in this class via online instruction? We found a moderate positive relationship [9] existed between the two items, $r(206) = 0.588, p < .001$. However, normality violations were apparent in our data. Because the data for these two items were negatively skewed, researchers transformed the data by square root. Finally, a relatively strong positive relationship was noticed between the two items, $r(206) = 0.613, p < .001$.

*Participants*

The participants completed an online survey in the spring semester of 2020. Participants were students from the College of Engineering at a public land grant university in the Midwest. Figure 1 explains the demographic information about the College of Engineering at this university [10].
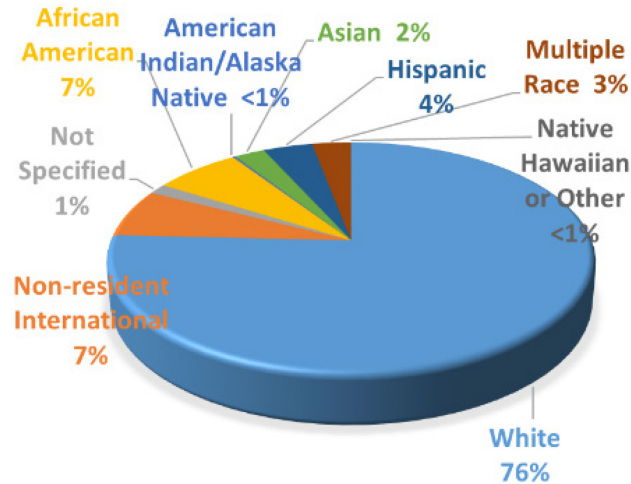
**Figure 1: College of Engineering Demographic**

The total number of responses was 189 and 180 for the open-ended question 1 and 2, respectively. Table 2 presents the participant demographics.

*Data Analysis*

1. *Open-Ended Questions* - We analyzed each answer to the questions using a phenomenological approach [2]. Open coding and axial coding methods were used to explore the categories related to students' concerns and challenges. The researchers determined which categories overlapped through the coding process to determine themes. Responses were initially coded by research team members and subsequent discussions then occurred to increase intercoder reliability and strengthen the trustworthiness of the findings. Two of the initial researchers coding are graduate students and the 3rd researcher is a tenured faculty with extensive research experience. Once the desired categories were agreed upon by the team, researchers then revisited the data to group three themes according to the established categories. Microsoft Excel was used as an organizing tool to facilitate the coding process.

2. *Two-Item Scale* - The data from scales were entered and analyzed using RStudio to calculate the means, standard deviations, and ranges.

**Table 2: Participant Demographics**

| Item | | Survey Questions | | |
|---|---|---|---|---|
| | | Question 1 | Question 2 | Scale Survey |
| Sample Size/The number of Responses | | 189 | 180 | 208 |
| Mean of Age | | 20.93 | 21.06 | 21.01 |
| Ethnicity | White/European American | 159 | 153 | 174 |
| | Black/African American | 4 | 4 | 4 |
| | Latinx/Hispanic | 3 | 2 | 3 |
| | Asian/Asian American | 13 | 13 | 15 |
| | Biracial/Multiracial | 3 | 2 | 3 |
| | Other | 6 | 5 | 6 |
| Gender | Female | 45 | 44 | 47 |
| | Male | 144 | 136 | 160 |
| Class Standing | First-Year | 17 | 17 | 19 |
| | Sophomore | 79 | 74 | 87 |
| | Junior | 60 | 57 | 66 |
| | Senior | 27 | 27 | 29 |
| | Other | 6 | 5 | 6 |
| Degree Program | Chemical Engineering | 22 | 21 | 22 |
| | Biological Engineering | 2 | 2 | 3 |
| | Biomedical Engineering | 13 | 13 | 13 |
| | Civil and Env. Engineering | 73 | 68 | 77 |
| | Electrical Engineering | 5 | 5 | 7 |
| | Computer Engineering | 5 | 5 | 5 |
| | Industrial and Manuf. Systems Engineering | 25 | 26 | 26 |
| | Information Technology | 2 | 2 | 2 |
| | Mechanical Engineering | 40 | 36 | 48 |
| | Other | 2 | 2 | 4 |

**Results**

*Open-Ended Question Results*

Ten categories emerged from our data, indicating engineering students' concerns and perceived challenges about the transition to remote instructions. These concerns and challenges were then categorized into the 4 general themes of instructors' ability, students' ability, difficulties outside the classroom, and no concerns. See Table 3 for the summary of themes, categories and their frequency. Moreover, we provided example illustrative quotes for each of the categories that described students' thoughts about the limitations of online teaching.

1. *Theme 1 Instructors' Ability* – Under this theme, students' concerns and challenges were related to instructors' ability to teach the course online.

*Instructional Limitations* - There were 108 statements coded in this category. One of the primary sources of this concern was a lack of opportunities for students to interact with their peers and instructors in the same way they would in a face-to-face classroom. For example, doing group work was difficult online. Furthermore, instructional support was insufficient in remote instruction. For example, some classes did not provide video recordings, so if participants missed a portion of the asynchronous online class due to environmental distractions, they could not watch the recording videos to compensate for their lack of knowledge. In addition, participants were concerned that much of the material could not be taught online, such as lab courses that required manual practice. The following quotes help to explain this category.

*"Working with my group-mates on the project can be an issue since we can't meet in person."*

*"Lectures not being uploaded on time."*

*"My main concern is the labs. Not only is it hard to complete all of the material online, but trying to meet virtually or on a call with lab partners is extremely difficult."*

*Seeking Help* - According to 42 responses, students reported difficulty in seeking help in online learning settings, including apprehension about asking questions in the Zoom classroom, instructors not providing enough office hours, and not receiving timely feedback on email questions from instructors.

*"Scared to ask questions, worried about what my voice sounds like and whether I missed the material earlier."*

*"The lack of office hours. Zoom cannot make up for in-person teaching and explanations."*

*Increased Workload* - Twenty-seven respondents expressed dissatisfaction with the amount of workload. The reason for this was partly due to an increase in tasks. For example, students had to watch additional videos and needed to complete more assignments than traditional classes. Exams were also a contributing factor. First, some instructors increased the difficulty and length of exams to prevent cheating. Second, students were not accustomed to taking online exams. For example, students did not have a chance to ask the instructors for clarification on questions in online exams.

*"My main concern is the addition of lecture assignments after each lecture. This has significantly increased the workload for this class, because on top of our regular weekly homework assignments, we have additional assignments, usually with less than 24 hours to complete them. In addition, when this class was held in person, all quizzes could be completed with a partner, obviously online that does not happen, and the quizzes are of the same difficulty."*

2. *Theme 2 Students' Ability* – This theme related to students' ability to learn materials online. The following categories explained the themes specifically.

*Time Management* - There were 59 responses addressing how difficult it was to track and complete tasks such as watching lecture videos and doing activities on time. Students were also concerned about how to allocate their study time when staying at home. When it came to making their own schedules, participants expressed difficulty with discipline.

*"Scheduling time to watch the Panopto lectures outside of normal class time can be a bit of a challenge."*

*"Most importantly, due dates on assignments and a timeline for studying. On campus, I felt like I had a bit more of an outlook on what was to come and when to start preparing and at home, I don't really feel that yet."*

*Lower Engagement and Motivation* - A total of 58 responses expressed students' concerns that engagement and motivation decreased.

*"I have more motivation when I am present in class. Being at home is too comfortable of an environment and causes me to be lazy."*

*Harder to Absorb the Material* - Fifty-four responses mentioned the increased difficulty of absorbing knowledge. Students struggled to keep up with the pace of instructions when they were taught online, and some classroom content became less comprehensible. Furthermore, not all students were able to learn well when accessing Zoom classrooms.

*"Difficulty completing labs and not performing well on exams because of the difficulty in learning through online lectures."*

*"Some of the explanations over zoom are hard to follow."*

*Hard to Focus* - Forty-seven statements reported not being able to focus on studies and being easily distracted in online classes. Some students were unable to focus on online classes because of their own degree of self-control. Some students were affected by their surroundings, such as pets and noisy environments. Also, some students had family responsibilities when they were studying at home, which distracted them from their studies.

*"Distractions from family/pets, easy to tune out what's happening in class."*

*"The hardest part is not conducting classes over zoom, but instead no longer having the school library as a quiet place to study. I have found that balancing internet, computer access, and other family responsibilities are much more difficult. Much more of my time has been demanded when I am not able to leave the house to study."*

*Worry about performance* - Twenty respondents voiced their concerns about their grades for the semester, such as not receiving extra credits and the impact of online instruction on their final grades.

*"This has been an extremely difficult transition for me and I am extremely anxious that the new situation will negatively impact my grade in this course."*

*"... maybe not being able to ask questions and get extra credit for participation."*

3. *Theme 3 Difficulties Outside the Classroom* –This theme demonstrates students' concern and challenges came from the outside of the online classroom. The one category was technology issues. Thirty-nine responses indicated that students experienced many technical difficulties. Some students had difficulty in accessing the internet at home. Also, poor network signals caused students to leave the class and lose some parts of classes. Additionally, instructors' cameras, microphones, and other equipment were not clear enough, and students faced a lack of other physical learning resources such as printers and desks.

*"... Both my parents and my three other siblings are now back home and trying to either work or take classes from home, so our Wi-Fi is overloaded at times."*

*"Stable internet is a concern to me. Since my internet is unstable, I usually watch teachers' recordings of their videos as well, but in this class, he doesn't record them."*

4. *Theme 4 No Concern* - There were 40 responses that indicated no concerns, perhaps because instructors did a satisfactory job of assisting students in adjusting to online classes.

*"I do not have any concerns because my instructor is doing a very good job with the transition."*

*"I think the online lecture format is very successful. The feeling is very similar to the in-person lecture and the help sessions have been frequent."*

Students seemed somewhat more concerned about their ability to learn the material (48% of responses) than the instructor's ability to teach the material (36% of responses). Difficulties outside the classroom were the lowest reported at only 8%, although some difficulties related to the sub-category of hard to focus may be caused by issues outside the classroom. Only 8% of the responses indicated that the students had no concerns. This relatively low number shows that the majority of students had some concerns about the transition to online learning.

Among the sub-categories, the instructional limitations or lack of instructional support (22% of responses) was a major concern and challenge among students. Almost twice the number of responses indicated that instructional limitations were a concern rather and a challenge. At the start of the pandemic students were uncertain and concerned on how their classes would be taught. Another major theme was time management (12% of responses). In this case, 50% more responses indicated it was a challenge than a concern. Students recognized their own difficulties in completing classwork if not regimented to in-class practices. Lower engagement and motivation (12% of responses) and difficulty in absorbing the material (11% of responses) were also major themes. However, almost an equal number of responses indicated this was a concern or challenge. Other themes, hard to focus (10%), seeking help (8%), technology issues (8%), increased workload (5%), and worry about performance (4%) were less reported. Interestingly the lowest reporting was in the theme about worry about performance. Although, students had many concerns and challenges their overall attitude toward their performance was still positive.

**Table 3: Summary of Themes in Open-Ended Questions**

| Themes | Sub-Category | Q1 Frequency (f) | Q2 Frequency (f) | Total Frequency (f) | Percentage (%) Sub-Category | Theme |
|---|---|---|---|---|---|---|
| 1 Instructors' Ability | Instructional Limitations | 71 | 37 | 108 | 22% | 36% |
| | Seeking Help | 24 | 18 | 42 | 8% | |
| | Increased Workload | 12 | 15 | 27 | 5% | |
| 2 Students' Ability | Time Management | 23 | 36 | 59 | 12% | 48% |
| | Lower Engagement and Motivation | 28 | 30 | 58 | 12% | |
| | Harder to Absorb the Material | 26 | 28 | 54 | 11% | |
| | Hard to Focus | 23 | 24 | 47 | 10% | |
| | Worry About Performance | 11 | 9 | 20 | 4% | |
| 3 Difficulties Outside the Classroom | Technology Issues | 16 | 23 | 39 | 8% | 8% |
| 4 No Concerns | No Concern | 25 | 15 | 40 | 8% | 8% |
| | Total Frequency | 259 | 235 | 494 | 100% | |

*Two-Item Scale Results*

The mean score of 208 observations for Item 1 (confidence in student's ability to learn the material) was 5.866, the standard deviation was 2.227, and the median was 6.00. The results indicated participants' s confidence in their ability to master their classroom knowledge was at an intermediate level via online instruction. The mean score for Item 2 (confidence in instructor's ability to teach the material) was 6.745, the standard deviation was 1.997, and the median was 7.000. Those values exhibit that participants' confidence in the instructor's ability to teach knowledge in online classes is moderate to high.

Interestingly, the score for the instructor's ability to teach the material was higher than the score of the student's ability to learn the material. Students seemed to still have significant faith and

confidence in their instructor to modify the instruction to meet the needs of remote learning, even if they themselves did not feel they would be able to succeed in remote learning. These results also align with the open-ended question themes indicating students had more concerns related to their abilities, than the instructors' abilities.

The overall results are in-line with additional work conducted by the research team at the same time. A study on the impact of the transition to remote learning on self-efficacy and outcome expectations [11] showed that despite the sudden change in instructional mode (from in-classroom to remote), students demonstrated a marginal increase in engineering self-efficacy scores (only 7%-8% increase in the mean score) and students' perceptions of positive and negative outcome expectations and persistence intentions did not change greatly. A survey at the end of the semester, also asked students "Did your motivation for learning in this class change after the class moved online?" Sixty-nine percent of students indicated that their motivation decreased and 27% reported that is stayed the same. However only 12% of the open-ended responses from the survey at the time of the transition talked about lack of motivation in courses.

**Conclusions**

Data collected through an online survey during weeks 8 and 9 of the academic semester, shortly after the COVID-19 shutdown in Spring 2020 demonstrated students concerns and challenges with the transition to remote learning. We noticed the four themes which were related to the instructors' ability to teach the material, students' ability to learn the material, difficulties outside the classroom, and no concerns. Students seemed somewhat more concerned about their ability to learn the material (48% of responses) than the instructor's ability to teach the material (36% of responses). The sub-categories of instructional limitations or lack of instructional support (22% of responses) and time management (12% of responses) were among the major concerns while the students did not express much worry about their performance (4% of responses).

The results from two-item scale indicated participants' s confidence in their ability to master their classroom knowledge was at an intermediate level via online instruction (6/10), and participants' confidence in the instructor's ability to teach knowledge in online classes is moderate to high (7/10). Students seemed to have more faith in the instructor's ability to teach the material than they had in their ability to learn it. The results aligned with the open-ended question themes and with a concurrent study on student's self-efficacy and outcome expectations [11].

From the data, we saw that students struggled with the online teaching model because of the instruction limitations. Those opinions had emerged from the previous studies [5]-[6]. However, students not only had concerns and challenges related to instruction but also had more concerns and challenges regarding their own ability to learn the material. Increased support for student learning techniques, such as time management, may help students address these concerns and challenges. The themes will be a valuable tool to help institutions and instructors improve students learning experience in engineering courses. Altogether students seemed to show a significant amount of resiliency regarding their education at the start of the pandemic.

## Future Work

The work presented in this paper is part of a larger research project investigating how changes in teaching practice can influence student social cognitions (self-efficacy and outcome expectations). As part of the same project, we built a faculty community and attempted to explore efficient teaching strategies to help students engage in classes and assessed student social cognitions (self-efficacy and outcome expectations). The data presented here in addition to data collected at other time points in Spring 2020 as well as Fall 2020-Fall 2021 will help inform the impact of teaching practices on social cognitions and give a greater understanding on the impact of the COVID-19 transition. In the future, we will report our findings synthesizing all the results.

## Acknowledgement

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