Understanding students' motivation-related experiences in different learning environments of summer engineering courses

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***Abstract*— This full research paper describes a qualitative investigation into the differences in student experiences in in-person and online summer engineering courses at an R1 institution in the U.S. Southeast. We investigated underlying factors influencing students' motivation-related experiences in in-person and online course formats in summer engineering courses through the lens of the MUSIC® Model of Motivation. We conducted 10 interviews with undergraduate students in online and in-person summer courses regarding their motivation-related experiences. Preliminary results identified prominent differences in the factors impacting student motivation in differing course formats. Across all courses, factors related to students' sense of agency, access to resources for success, and instructor empathy were most frequently identified as essential for positive student experiences. Particularly, having access to peers and the instructor, instructor caring, and a sense of agency over the learning process contributed positively to student experiences across nearly all flipped format courses. While the absence of these factors contributed negatively to student experiences in most online and in-person lecture-based courses, such outcomes were not uniform, and insights from students with positive online course experiences point to actionable tools and techniques instructors can use to create more universally positive online education experiences. Taken together, these results highlight areas of improvement for future course designs of online and lecture-based summer engineering courses to contribute to positive student experiences more consistently.**

Keywords—distance learning; online learning; student motivation

I. INTRODUCTION

A. Background of the study

Shift towards online learning in engineering education

Historically, engineering education has been characterized by classroom instruction, laboratory experiments, and hands-on projects. To enhance the facilitation of engineering education, various teaching approaches, including active learning [1], the flipped classroom [2], and project-based learning [3-5], have been introduced and proven effective. In recent years, online learning is emerging as a vital and integral component of engineering education due to the opportunities it offers. This shift is fueled by technological advancements [6], changing educational paradigms [7], and the global need for accessible learning experiences [8]. Also, the recent COVID-19 pandemic introduced an unprecedented and global need to explore online teaching/learning opportunities across the spectrum of educational levels and majors [9]. Even after most institutions transitioned back to in-person operations, student demand for online programs continues to grow, and universities are stepping up to meet that demand [10]. This paper details student experiences in one such engineering program that began offering online summer versions of foundational courses during the COVID-19 pandemic and is presently continuing to grow these offerings.

Online learning is defined by learning experiences in either synchronous or asynchronous environments, utilizing various devices such as phones and laptops with internet access [11]. These environments offer opportunities for students to learn and interact with instructors and peers from any location [12]. In the synchronous learning environment, students participate in live lectures, engage in real-time interactions with educators and peers, and have the potential for immediate feedback [11]. Furthermore, Synchronous learning offers ample opportunities

for social interaction [13]. In contrast, asynchronous learning environments lack this structured format; learning content is dispersed across various systems and forums, without live lectures or classes [11]. Consequently, instantaneous feedback and immediate responses require more intentional design than in-person courses where the instructor can respond to students immediately [14].

Despite the unique challenges associated with online learning, research has demonstrated that online classes can be at least as effective as traditional classrooms for learning. For instance, Abdous and Yoshimura's [15] study found that there are no statistically significant differences in final course grades or satisfaction levels among learners enrolled in face-to-face, satellite broadcasting, and live video-streaming sections of the courses they analyzed. They further proposed that distance education could serve as a feasible, convenient, and flexible alternative delivery method, expanding learning opportunities to non-traditional students. Additionally, a meta-analysis conducted by Allen et al. [16] comparing student satisfaction with distance education to traditional classrooms in higher education revealed that distance learning does not diminish the level of student satisfaction when compared to traditional face-to-face methods of instruction. Findings by York [17] reinforce the notion that online classes can achieve comparable outcomes to traditional classes based the comparison study of students' knowledge gain, course grade, and self-efficacy in traditional, internet and hybrid course format.

B. Statement of the Problem

While online learning has the potential to serve students as well as in-person learning, programs not accustomed to offering online courses likely require time and appropriate feedback to learn how to create quality online learning experiences. We were motivated to conduct this study by the results of an initial assessment comparing student performance in online vs. in-person summer courses at our institution (Fig. I). The assessment found that students in online summer courses performed significantly worse in terms of course grade compared to student performance in in-person sections. Furthermore, it revealed that students who performed poorly in online classes tended to perform well below their average GPA, suggesting that poor student performance is attributable to factors beyond students' typical academic aptitude. These results were robust across multiple courses and instructors, suggesting systemic issues related to online learning rather than factors attributable to a specific course or instructor.

Recognizing the disparate outcomes of our students in summer online courses vs. in-person courses, we sought to understand the experiences of students in these courses and identify how the online courses could be improved. We elected to study student experience from the perspective of student motivation, as decades of educational psychology research has established motivation as a well-defined construct with robust influences on student learning and success [e.g., 18, 19, 20]. The specific problem this research addresses is how the structure of online summer courses at our institutions could be modified to enhance student motivation to positively impact students' course

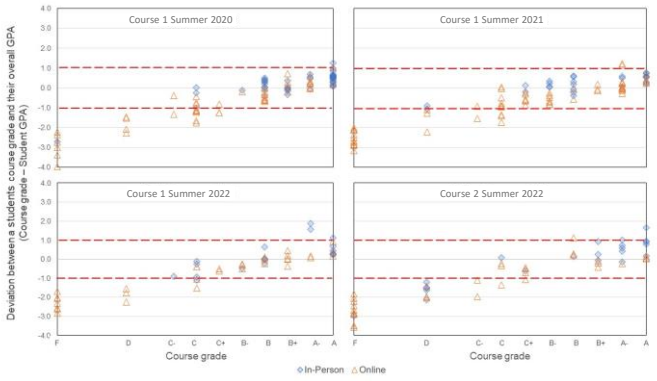

Fig. 1. Results of student performance assessment in engineering summer online courses (orange triangles) vs. in-person courses (blue diamonds). Each point represents a students' grade in the course (x-axis) and its deviation from their average GPA (y-axis). Points outside of the y-axis center range (denoted by red dotted lines) indicate substantial differences between course grade and average GPA. Note that almost all students who achieved less than a C grade in online courses performed well below their average GPA.

outcomes. Further, by connecting to an established theory of student motivation, we intend our findings to build upon existing work in the areas of student motivation and online learning.

II. Literature Review: Online Education & Motivation

The concept of online education, teaching and learning without the constraints of time and space [21], has a rich history and, with the proliferation of EdTech, has ushered in a transformative era in learning and instruction[22]. It has evolved from using printed materials and mailed resources to radio, television, and now, computer and internet technology [23]. As student demographics change, colleges and universities are adapting by offering online courses to cater to non-traditional students, such as older students, those with families, or working professionals that require flexible schedules and location. Online educational content can be presented through a variety of synchronous or asynchronous media, including video, animated podcasts, PDFs, and more [21, 24, 25].

Advantages of online learning, such as flexibility, interactivity, and self-pacing, make it a compelling alternative to in-person teaching. Its flexibility allows students worldwide to access coursework and resources without distance barriers [26], catering especially to professionals and working students. Furthermore, technological advancements have enabled platforms like virtual laboratories, simulation software, and interactive multimedia resources. Also, collaboration tools facilitate group projects and peer learning in virtual environments [27]. Additionally, online learning environments, like virtual labs, prove cost-effective by reducing setup and maintenance expenses [28] . Moreover, personalized learning experiences tailored to individual preferences can be facilitated by online platforms.

However, online learning environments face unique challenges compared to traditional classrooms, lacking face-to-face interaction and potentially limiting communication richness.[29] Technical issues may also affect the learning experience. Other challenges associated with online learning include motivational problems [30], maintaining academic integrity [31], difficulty in fostering cognitive engagement [32] and sense of community [28, 33] among participants of online or virtual learning environment. Efforts are ongoing to address these challenges and ensure the quality and efficacy of online education. For example, the study by Dunmoye et al, [27] suggest integration of social interaction strategies into VR instructional design could enhance students cognitive engagement within in the virtual environment. Additionally, to enhance student-teacher contact which is essential for effective online learning, the study by Richardson, Ice and Swan [34] suggested creating "Meet Your Classmates" section in which teacher and students in online learning environment could meet, discuss and introduce themselves one to another.

With the rise of online education, researchers have increasingly focused on understanding student motivation because of its association with learners' outcomes such academic success, and retention [35]. A study by Hartnett [36] posits that motivation in online learning primarily depends on the individual characteristics of learners and the particular context of the learning environment. Furthermore, the study by Ozhan and Kocadere [37] found that incorporating games into online learning environment could foster a sense of flow and affective experiences which can significantly impact students motivation. Past study has also noted that the nature of the task could affect students' motivation. For example, the study by Çebi and Güyer [38] revealed that there is a positive correlation between the level of students engagement with online course materials and their motivation.

Due to the important role of motivation in students' learning experience any learning environment, the goal of our study was to capture a wide range of motivation-related experiences in online, summer engineering courses, and to compare these experiences to those in in-person courses. We selected the MUSIC® Model of Motivation to accomplish this goal. Created by Dr. Brett Jones [18, 39], the MUSIC Model posits that student motivation to learn in a class can be explained through five empirically investigable variables (defined in Table I), each derived from a survey of established theories of motivation. These five components served as the theoretical basis of our data collection and analysis process. The MUSIC Model has been successfully used to study a variety of engineering education contexts, including online courses [40], several specific in-class activities [41-43], and co-curricular programs [44-46].

TABLE I. DEFINITIONS OF MUSIC MODEL COMPONENTS

MUSIC Component	Definition
E(M)powerment	The extent to which students believe they have meaningful control over their learning.
(U)sefulness	The extent to which students believe the material will be useful to them in the future.
(S)uccess	The extent to which students believe that they can be successful if they put effort into learning.
(I)nterest	The extent to which students find learning activities interesting and enjoyable, both in terms of short-term attention (situational interest) and long-term intrinsic engagement (individual interest).
(C)aring	The extent to which students believe their instructor and peers care about their success and well-being.

III. METHODOLOGY

This section details the qualitative research design employed to understand factors influencing students' motivation-related experiences in different learning environments of summer engineering courses. Our study answers the following research question:

What aspects of online summer engineering courses did students perceive as affecting their motivation, and how did these perceptions compare to those of in-person courses?

The study's details were submitted to our institution's human subjects research review board (IRB), who determined that it did not require IRB oversight because its primary purpose was program improvement rather than publication, despite being informed of our intent to publish.

A. Research Design

Our study employs qualitative methods to explore the personal experiences of students across various learning environments in summer engineering courses: online synchronous, online asynchronous, in-person flipped, and in-person conventional settings. Qualitative research, as highlighted by Joanne [47], provides insights into situations or phenomena by narrating stories rather than establishing cause and effect relationships. Through semi-structured interviews, we aimed to gather rich, detailed data depicting the differences in student experiences across different course formats.

B. Participants

The participants in this study were undergraduate engineering students at an R1 institution in the southeastern United States who enrolled in one or more summer engineering courses. A recruitment survey was distributed to all engineering students who took a summer course between the years of 2021 and 2023, yielding 10 voluntary responses for participation in in-depth interviews. Participants were assured of the voluntary nature of

their involvement and the confidentiality of their identities. Each participants received a $10 Amazon gift cards as compensation for their participation. Table II describes the course formats discussed by each participant. Not all students discussed all formats, and some students discussed their experiences with online courses in aggregate, rather than specifying a format.

TABLE II. COURSE FORMATS DISCUSSED BY PARTICIPANTS

Participant (Pseudonym)	Online Format	In-Person Format(s)
Chris	(Not discussed)	Lecture
David	(Not discussed)	Lecture
Geet	Synchronous (flipped)	(Not discussed)
Tejumola	Synchronous	(Not discussed)
Evan	Asynchronous	Flipped
Nhu	Asynchronous	Lecture
Javier	No specific format	Flipped
Yago	No specific format	Lecture, Flipped
Sarah	No specific format	Flipped
Fred	No specific format	Flipped

C. Data Collection

We interviewed a sample of 10 undergraduate students. Each interview lasted approximately 1 hour and followed a semi-structured interview protocol comprising 12 questions. These semi-structured interviews delved into student experiences and perceptions of motivation during summer engineering courses. The interview protocol used was adapted from protocols presented by Brett Jones, which were derived from the MUSIC Model of Motivation [18]. We selected this model because it encompasses a broad range of motivational constructs, offering a comprehensive approach to understanding student motivation.

The interview protocol initially asked students to focus on one particular course format (in-person or online) to understand their motivation-related experiences. However, after the first four interviews (Chris, David, Geet, Tejumola), we realized it would be more helpful to ask students to directly compare their experiences with in-person and online formats. Our final interview protocol is included in the appendix.

D. Data Analysis

The interview audio was transcribed using Otter.ai software [48] and manually corrected for accuracy by one of the authors. The interviews underwent a thorough review and cleansing process to ensure data familiarization and accuracy. Subsequently, they were imported into MAXQDA qualitative data analysis software for deductive analysis [49, 50]. During the interview phase, it became apparent that students had enrolled in courses with varying instructional designs over the summer. Consequently, we categorized these designs into three overarching categories: Lecture only, In-person flipped, and online. This categorization was crucial for segregating and examining data pertaining to different teaching strategies. Employing a deductive approach, researchers discerned patterns across the data, iteratively cycling between the identified themes and the data until comprehensive results were attained.

E. Positionality Statement

The research team was comprised of engineering education researchers in an engineering education institute that cuts across UGA's College of Engineering. No members of the team were involved in teaching any of the course sections studied. The data collection process was led by the third author, a White U.S. man who was a graduate student in the engineering department who ran the courses studied. The data analysis process was led by the first three authors. The first and second authors are Black Nigerian men who were graduate students in the engineering education institute. The fourth author, a White U.S. man who is a professional track engineering education faculty member, supervised all three students throughout the study. The fifth author is a member of the College of Engineering's Dean's Office; he proposed the study and provided regular feedback on progress and results.

While the research team considers ourselves independent from the social reality being studied, the fourth author has a strong working relationship with the instructors of the courses studied. Out of respect for these instructors, our team takes the position that these instructors did the best they could with the knowledge and experience they had. Our study focuses on addressing systemic issues across course sections, not criticisms of particular instructors.

IV. RESULTS

A. Overview of Findings

The varied experiences of students across multiple course formats enriched our study, providing a more comprehensive understanding of student perceptions. Through thematic analysis, we pinpointed key factors influencing motivation, such as a sense of agency, perceived usefulness, feelings of success, and instructor empathy. Notably, a sense of agency, access to resources to support student success, and instructor empathy consistently emerged as the most emphasized elements for fostering positive student experiences. Conversely, factors related to usefulness or interest, representing the more individualized aspects of the MUSIC Model, did not exhibit noticeable differences across various course formats.

B. Factors that Influenced Student Motivation

1) Empowerment

The concept of empowerment, which involves students' belief in their ability to control their learning, plays a crucial role in motivation. Students who perceive control and take ownership of their learning tend to be more motivated and persistent. Among the 10 interviews analyzed, five highlighted the positive influence of in-person flipped classrooms on their sense of empowerment. For example, one student, Yago, discussed how having control over his learning process positively impacted his summer experience.

> I (Interviewer): So, to what extent would you say the course was instructor-led versus student-led?
>
> P (Participant): I'd say like 30-70, they would spend the first 20-30 minutes working through a problem or stuff like that.

> And then afterwards we would work as a classroom or with our groupmates. So, I don't know, maybe like 30-70% of lecture but then working through a lot with the professor and then the rest of the time as student led groups.
>
> I: Okay, would say that overall, you were a more active participant in the learning process?
>
> P: For sure, for sure.

Yago's response illustrates how this sense of control positively influenced his learning experience. He described a collaborative environment where students actively engaged with course material and problem-solving tasks. Yago highlighted that the professor facilitated student autonomy by intervening only when necessary, fostering a more interactive and motivating learning environment. He said:

> P: I'd say one thing I learned is that I used to think I didn't like the flipped style course. I think I learned that I do. I do actually like that style. It's a little more engaging and forces you to be more engaged when you come to class. And I didn't know that until I took it. So that was one thing.

In contrast, when discussing an online, asynchronous class setting, Evan highlighted the predominant role of the instructor in leading the course, while students took on a relatively passive role as recipients of knowledge:

> I: So, to what extent did you feel you had control over your learning experience? In other words, would you consider yourself a more or less passive consumer in his course? Or were you more active in learning process?
>
> P: Yeah, I think there was, you know, there was one way to consume the material for everyone. And it felt super restrictive. Yeah. So, you were kind of forced to be really passive, and just, you know, write down what the video had to say, and then do a problem or two.

In this case, Evan reported that students were more passive learners, left with no choice other than to consume the material given. The online format, with pre-recorded lectures and limited interaction with other students, led to decreased motivation for Evan. He struggled to learn independently and missed the in-person interaction where students are encouraged to take charge of their learning. Students discussing in-person, lecture-based courses made similar comments. Their collective descriptions highlighted the suboptimal impact of instructor-led teaching methods on student motivation.

2) Access to resources to success

Access to resources such as the professor, peers, self-paced work, and instant feedback plays a key role in student experiences. Many students described in-person, flipped format courses positively in terms of having access to their professor. For example, Javier said:

> P: Yeah. Just the way it was flipped format. It helped a lot outside of class. Because any problems you might have been stuck on in the videos, you can get them answered in person. Compared to online classes I had taken, if I had questions, I didn't really know how to ask the professor outside of class. So, I feel like that was a good thing about how the course was structured, where we go into class, do some problems, ask some questions, and clear up any unknowns.

In Javier's interview, he spoke positively about the professor's accessibility, both during class time and through office hours. He mentioned the professor's willingness to answer questions and provide additional feedback support contribute to his motivation and engagement with the course material. Also, he emphasized the importance of connecting with peers in the class, learning at his own pace, and the availability of recorded videos for review later review. Students found the in-person, flipped format beneficial for discussing concepts, working on problems together, and forming study groups. Also, in the only flipped online environment, Geet also highlighted the positive influences of having access to her professor helps in motivating her, for example, Geet said:

> P: Our professor was someone who wanted us to do good. They never just like stuck to their job and just finished for the day. They were open to emails. They would let us know if they had something going on or be open to hearing if we had things going on that affected our progress and such. But yeah, they were definitely one of my favorite engineering professors.

However, in comparing students' past experiences in an online class environment, most students discuss challenges in access their professor, forming online study groups, which can negatively impact their motivation due to reduced social interaction and support. Also, some participants discussed that lecture-heavy online courses diminished motivation due to limited engagement and interaction opportunities. Sarah contrasted her experiences in flipped class with those of an online course:

> P: Oh, it was totally different because it wasn't personal, it was obviously hard to make that connection. So, I definitely do like it better in person, because I can connect better with my peers and everything. And I was able to actually form those study groups, I did have study groups during COVID but it was hard to get to email people, or get them all together. So definitely, in person has been a lot better. It was harder in the online courses.

Similarly, Evan discussed his past experience of an online class format:

> P: The things that kind of turned me away was [sic], you know, I didn't really have access to the professor. I was teaching myself the material, essentially. And it just felt like all he was doing was administering the tests.

Students' comments reinforced the notion that access to professors and peers, along with self-paced learning and

feedback, significantly impact student success and motivation. Challenges in forming online study groups and the impersonal nature of online courses hindered their motivation.

3) Instructor empathy

Instructor empathy plays a vital role in motivating student experiences. When instructors demonstrate understanding and support, students feel more engaged and motivated to succeed despite the challenges of condensed schedules and external pressures. A key aspect of caring is that students believe that the instructor cares about their learning. In our findings, professor caring shows up in almost all in-person, flipped courses and some online, contributing positively to student experiences. For example, in a summer flipped class, Sarah told the interviewer:

> P: [The professor] would always ask questions to the students like oh, are you having any questions? Do you understand this? And they'd go over it again.

Another student, David, described how receiving help during in-person office hours after a poor test resulted in a greater sense of success:

> P: I remember when I didn't do very well on the first test. So, then I immediately went and visited the professor during office hours. And they kind of helped me through the mistakes I made. What I can do better on the next test. So, it was definitely a lot better after that.

On the other hand, online courses presented a mixed picture regarding instructor empathy. While some students experienced supportive interactions, others faced challenges. Nhu described a positive experience in an online course:

> P: So, after the first test, the grades were not the best. And a lot of people had to schedule meetings [with the professor]. When we talked with them, they made everyone feel a lot better, because they said that they would distribute the weight differently for tests. And after that, we also found out what specific kind of questions would be on the test, [so we] felt a little more prepared later on. They made sure we all knew what we were doing, you know?

Nhu further said:

> P: It felt nice to have a teacher that, you know, cared about everyone's performance in the class. They were really looking out for us to make sure that we really did understand the content and like, what they could do better or offer any additional resources and stuff like that, too.

Other descriptions of online courses were less flattering. Evan described an instructor unwilling to offer alternative office hours outside of a fixed schedule, hindering access to support and contributing to a general feeling of indifference towards student concerns. Evan viewed one of the main advantages of online courses as their schedule flexibility, allowing him to work a summer job at the same time, but noted this advantage was undermined by a lack of instructor flexibility:

> P: [The professor] wasn't really willing to work around my schedule, in terms of like office hours. Because I was like, hey, you know, I work from this time to this time and I can't make your office hours. He was never willing to meet outside of that. You know, he didn't really offer that up and show that he really cared about me, I guess. I know a lot of people ended up having similar sentiments and performed poorly in that class as well.

These findings suggest that instructor empathy plays a crucial role in motivating student experiences. In flipped courses, it was evident that students believe that instructor cares about their learning. However, in online courses, instructor empathy varied, with some students receiving supportive interactions while others faced challenges, such as inflexible scheduling. Negative perceptions of instructor indifference can hinder student motivation and performance in these cases, highlighting the importance of empathetic teaching practices.

4) Interest in Material

Interest in the course material plays a crucial role in student motivation, engagement, and overall learning outcomes. When students find the material interesting, they are more likely to actively participate, engage with the content, and persist through challenging concepts. Interest Theory and the MUSIC Model both discuss two broad types of interest: individual interest (the topics of activities someone enjoys) and situational interest (things about a present experience that capture someone's attention) [18, 39, 51, 52]. We found that individual interest was not something students discussed as being affected by a given course, but rather predisposed their willingness to engage with the course. For instance, when describing an in-person, lecture class, Chris was asked:

> I: How motivated would you say you were to engage in the material in this class?
>
> P: Honestly, not super motivated. Fluid mechanics is not my thing, I guess.

While responses like this may be interesting for some studies, they did not help answer our research question regarding how specific elements of a course impacted student motivation. We found that student comments around situational interest were more appropriate for our analysis. For example, Tejumola discussed being demotivated by the need to watch several very long videos as part of a synchronous, online course, on top of doing many time-consuming problems:

> P: The videos were long and it was a lot of practice problems. And they were very long like to get to the questions and everything. And I don't think I was in a space to be doing all of that to be fair. And so even if I did at first [try], the motivation just fizzled out.

Despite his initial enthusiasm, Tejumola struggled to maintain momentum in the face of such overwhelming challenges. The lack of support and interaction in the online format only added to his sense of isolation and frustration and finally lost of interest in the material.

Overall, students discussed situational interest infrequently compared to the factors discussed in prior sections of this paper, leading us to acknowledge that situational interest was a factor for some students, but one with relatively little impact.

5) Usefulness of Material

The perceived usefulness of course material is also an important factor in assessing student motivation. To foster a more engaging learning experience, instructors can ensure that students understand the relevance of the content, its impact on their career goals (short-term and long-term), and its practical applications beyond the classroom. However, like with individual interest, students only discussed usefulness in terms of their predispositions toward the topic of the course. Because few specific aspects of courses were cited as affecting student perceptions of usefulness, we did not analyze this aspect of motivation further.

V. Discussion

A. Implications of Findings

The results of this study illustrate the significant differences between student experiences in in-person classrooms and online courses at our institution, indicating that specific factors are crucial for positive experiences in summer courses. These factors include a sense of agency, access to success-enabling resources, and instructor empathy. However, our findings suggest that these elements can be difficult to achieve in online environments.

A sense of agency (empowerment) is key to sustaining student motivation. Our findings show that in-person flipped classrooms offer greater autonomy and flexibility, resulting in increased engagement and motivation among students. This observation aligns with Deci & Ryan's self-determination theory, which suggests that intrinsic motivation is rooted in autonomy [53, 54]. To foster empowerment in online classes, educators can aim to create student-centered environments with collaborative learning opportunities and flexible assignments. Technology can play a pivotal role in this process. Tools like Canvas and Google Classroom help manage courses and assignments, while collaboration platforms such as Slack and Discord facilitate peer interaction. Digital whiteboards like Miro and interactive content platforms like Kahoot! can be used to create quizzes and promote student engagement, thereby fostering collaborative learning and enhancing student agency in online settings.

Access to resources, including instructor support and peer collaboration, is essential for student motivation and success. Flipped classrooms excel in this area, providing in-class interaction that scaffolds student learning through social interaction—an approach popularized by Vygotsky's theory of social constructivism [55]. To improve resource accessibility, instructors can offer flexible office hours and interactive activities, especially in online courses where students may feel isolated. Nhu's positive experience in an online course illustrates how these principles can be applied in virtual settings. She appreciated having multiple communication channels, such as Piazza and GroupMe, which facilitated peer collaboration and access to instructor support, creating a sense of community. This example shows that even in online courses, fostering opportunities for interaction can enhance student engagement and reduce feelings of isolation.

Furthermore, we investigated whether students felt empathy and caring from their instructors. We found that in-person flipped classrooms generally reflected higher levels of instructor empathy, contributing to a more positive learning experience for students. Conversely, most online courses were reported to have lower levels of empathy, with students frequently citing a lack of supportive interactions. This finding is consistent with Noddings' study focusing on the importance of caring in education and emphasizing that an instructor's empathy can be a critical factor in student success [56]. The clear gap in instructor empathy between in-person/flipped classrooms and online courses highlights the need for online instructors to find ways to create more supportive and engaging environments. An example from our interviews illustrates this point. Tejumola, when describing an online course, noted that feedback was often delayed, and emails went unanswered for extended periods. She described how these issues made it difficult to feel connected to the course and the instructor. To address this, online instructors must prioritize timely feedback and responsiveness to foster better student outcomes and a more positive learning experience.

Also, we found that students' individual interest in course materials and their perceived usefulness of course content were largely unaffected by course format. This indifference suggests that these factors might not play as significant a role in student motivation as previously thought. Despite efforts to engage students through relatable content and real-world applications, our observations revealed a consistent lack of strong enthusiasm or engagement across all course types. This finding indicates that other aspects of the learning environment could have a more substantial impact on motivating students in summer courses.

B. Limitations of the Study

This study relied on interviews with 10 students to understand their experiences across various summer course formats. While these interviews yielded valuable insights, they do not necessarily reflect the experiences of all students. Additionally, the students' performance in particular courses could influence their perceptions. For instance, students who did not perform well in online courses might express more negative opinions about online formats, thus skewing the study's findings.

C. Future Research Directions

We recommend that future research in online engineering education focus on experimentally comparing course structures to assess their impact on student motivation and performance in summer engineering courses. Longitudinal studies can track motivation over time, revealing the sustainability of course design choices. Research into technological tools, such as

gamification or virtual reality (VR), could offer insights into enhancing online learning engagement. Examining instructor-student interactions in online settings is critical, as is exploring collaborative learning's role in fostering a sense of community. Understanding factors behind student motivation could help reduce attrition, and incorporating cultural and demographic considerations may guide efforts toward more equitable learning environments.

VI. Conclusion

The swift national shift to online learning during the COVID-19 pandemic highlighted the adaptability and resilience of higher education institutions. Experts anticipate continued growth in online course programs but caution that the challenges online learners face will require ongoing attention and effort[57]. Our study, conducted through the lens of the MUSIC Model of Motivation, suggests that students often face difficulties in online classes. We found that factors like empowerment, access to resources, and instructor empathy are crucial for motivating students in traditional classrooms, but these are often missing in online environments. These findings imply that instructors must be intentional in their approach to online teaching by creating a more engaging and enjoyable learning experiences to boost student motivation and success.

We recommend using technological learning tools to keep students engaged and minimize boredom in online settings. Interactive quizzes like Kahoot! and Quizlet can add an element of fun to learning, while collaborative platforms such as Slack and Discord foster peer-to-peer interaction. Digital whiteboards like Miro and Jamboard facilitate brainstorming and teamwork, and video conferencing tools such as Zoom and Microsoft Teams enable real-time communication and class participation. Additionally, Learning Management Systems (LMS), including Canvas and Blackboard, help instructors organize course content and create engaging activities. Despite their benefits, these tools are often underutilized at our institution. By fully leveraging these tools, instructors can encourage real-time interaction, collaboration, and a sense of community, making online classes more dynamic and appealing to students.

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IX. Appendix: Interview Protocol

1. [Jog memory] Is there a particular online and in-person engineering summer course that you've taken that you remember well? What year did you take them?

2. [Overall experience] Did your overall experience of [this] course motivate you to want to meet the goals/plans you described earlier more or less than in the [other] course?

   a. How motivated were you to engage with the material in [this] course compared with the [other]?

   b. Were there any specific aspects of [this] course that helped to motivate (or demotivate) you more so than in the [other] course?

3. [Usefulness] What were your key take-aways from [this] course and the [other]? In what ways are each related to your career interests and goals we talked about earlier?

4. [Usefulness] What did you find useful (or not useful) about [this] course compared with the [other]?

5. [Success] What aspects of how [this] course was structured helped you feel that you could succeed compared to the [other]?

   a. What kinds of things did the professor do to help you succeed in [this] course compared to the [other]?

6. [Success] What aspects of [this] course or the professor's actions do you believe hindered your success compared to the [other]?

7. [Caring] How much did the Professor want you to succeed in [this] course compared with the [other]?

   a. How do you know?

8. [Empowerment] To what extent did you feel that you had control over your learning experience in [this] course compared with the [other]? For example, would you consider yourself a passive consumer of the course content, or a more active participant in the learning process? Or somewhere in between?

10. [Interest] What did you find most interesting about [this] course compared with the [other]?

   a. What parts of [this] course were boring or failed to hold your attention compared with the [other]?

11. [Interest] What could be changed to make either course more interesting?

12. [Closing] Is there anything about your experience in either course that we haven't talked about, that you would like to share?