Effects of Distance Learning on African-American Students in Engineering Technology Courses During COVID-19 Pandemic

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Abstract

Until 2019, many students enrolled in online courses for advantages such as flexibility and financial benefits. Research shows that online students made up 32% of the total enrollment in 2013. The number continued to grow for many majors; however, previous research does not investigate online learning for laboratory-based engineering courses and its effect on minority students. When the US declared COVID-19 as a pandemic in the spring of 2020, many universities in Florida suspended their in-person classes and shifted to online modality. This sudden shift happened in the middle of the semester, affecting students' educational experience and academic performance. This paper investigates the effects of distance learning on the academic performance of African American minority students' population for lecture and laboratory courses in the Electronic Engineering Technology (EET) and Construction Engineering Technology (CET) programs at Florida Agricultural and Mechanical University (FAMU).

This paper compares students' success in two courses (one lecture and one laboratory) from each major taught over two different modalities: distance learning and in-person learning over three academic terms. The courses selected are Introduction to Robotics and Introduction to Robotics Laboratory for EET and Strength of Materials and Strength of Materials Laboratory for CET. A total of 47 students (20 from EET and 27 from CET) academic performances were measured in those two courses. The effects of student background variables (race, financial background, ease of using, and availability of the internet) and course-related variables (difficulty level of the course, available course-related resources on Canvas, lab-based vs. lecture-based course) on student success were explored through student surveys. To measure students' performance, the academic grades they received in the courses were used. To assess student satisfaction with each course, students had to take surveys. The results indicated that, for lecture-based courses, the performance remained almost similar for both modalities; for laboratory courses, student performance and satisfaction were low for the distance learning modality. Both results indicated that students needed some personal interaction for laboratory-based courses to understand and perform the labs. These results provided the Engineering Technology program insights into how laboratory experiments can be more effectively delivered to minority students in distance learning.

Keywords: African- American, COVID-19, Online Learning, Distance Learning

Introduction

Distance learning has been growing in popularity in recent years. However, the COVID-19 pandemic in 2020 led to a significant shift towards virtual education, as traditional teaching methods had to be adapted to a virtual platform due to the necessity of social distancing measures and remote learning [1]. Many students opted for virtual courses due to the flexibility and financial benefits they offered before the COVID-19 pandemic [2]. However, this global crisis brought an unprecedented need to widely implement and explore virtual teaching and learning across all levels of education and subjects. According to UNESCO, the pandemic resulted in over 1.5 billion students (90.1% of total enrollees) worldwide facing educational changes due to school closures.

This sudden shift to online or blended learning caused traditional, in-person teaching institutions to face challenges in the rapid transition [3].

Though previous research has investigated the advantages of online education, it is mostly focused on non-practical, theoretical courses rather than courses that require hands-on, laboratory-based learning. In other words, the effects of online learning on courses that involve laboratory work, such as engineering, have not been fully studied or understood. This gap in research means that it is unclear if the benefits of online education identified for theoretical courses can be applied to laboratory-based engineering courses. It may be that online learning is less effective for such courses because the hands-on nature of laboratory work cannot be replicated through a virtual platform. As a result, further research is needed to understand the impact of online learning on laboratory-based engineering courses.

Online learning has numerous benefits, including the convenience and flexibility it provides. However, it has also raised concerns about the disparities faced by minority students who lack access to technology, experience social isolation, face technical difficulties, and lack adequate support. These inequalities have been an ongoing issue for over two decades and have been further exacerbated by the shift to emergency online learning brought on by the COVID-19 pandemic. This is particularly important for minority students as the courses in Engineering programs are often prerequisites for further coursework and professional certifications. Therefore, understanding the impact of online learning on the academic performance and satisfaction of African American minority students in laboratory-based engineering courses is crucial. This study aims to fill that gap by investigating the impact of distance learning on the academic performance of African American minority students in the Electronic Engineering Technology (EET) and Construction Engineering Technology (CET) programs at Florida A&M University. The study will compare students' success in two courses (one lecture and one laboratory) from each major taught over two different modalities: distance learning(synchronous online learning) and in-person learning over three academic terms. The results of this study will provide valuable insights into how laboratory experiments can be more effectively delivered to minority students in distance learning and also inform the effectiveness of online learning as a viable option for laboratory-based engineering courses.

Literature Review

According to the Babson Survey Research Group, an online course is defined as at least 80% of the content being delivered via the internet, while a face-to-face instruction course involves a situation where only 0 to 29% of the course material is delivered online [2]. Distance learning, on the other hand, refers to any form of education provided without the teacher and students being physically present [4]. Over the past 20 years, the development of online education has been the subject of several studies, and it has been observed that the enrolment of students in online courses has consistently increased since 2002. According to the most recent report by the Babson Survey Research Group in 2019, it was found that 32% of students enrolled in higher education in the United States in 2017 were enrolled in at least one online course [2]. This trend is continuing to rise, especially in fields such as business, nursing, and education. The growth is attributed to the flexibility and cost-effectiveness that online courses offer [5].

While the growth of online education has been well-documented, there is less research on the impact of online learning on minority students, particularly African American students. Previous studies have found that African American students often face additional challenges when enrolled in online courses due to the digital divide [6, 7]. These challenges include inadequate

access to technology, lack of access to high-speed internet, and lack of familiarity with online learning environments [8, 9]. Furthermore, research shows that African American students are less likely to succeed in online courses due to their lack of access to technology and resources [10, 11]. Also, little research has been done on the effect of online learning on laboratory-based engineering courses, and even less on the effects on minority students. The sudden shift to online learning due to the COVID-19 pandemic in the spring of 2020 has highlighted the need for research in this area. In terms of student performance, studies have shown mixed results for online learning compared to in-person learning [12]. Some studies have found that online students performed as well or better than in-person students [13], while others have found that in-person learning is associated with better academic performance [14]. The impact of race and financial background on student success in online learning has also been explored in previous research. Studies have found that students from lower-income backgrounds and minority students face greater challenges in online learning, such as limited access to technology and the internet [7, 11, 15].

A study has demonstrated that the abrupt transition to online education during the middle of a semester can harm students' academic performance and overall educational experience [15]. This report also revealed that students in virtual courses received lower grades and had a lower completion rate than their peers in traditional in-person courses. Additionally, a study conducted for Business English courses in higher education discovered that students in online courses reported a lower level of satisfaction with their courses than students in face-to-face classes [16] . The switch to online learning was also found to have an even greater negative impact on students of color [17].

The field of engineering education emphasizes practical laboratory experiences, which are important for students to develop their skills and knowledge [18]. However, conducting these experiences virtually can be challenging [19]. Existing research has shown that students in online engineering courses score lower on laboratory performance evaluations than those in traditional, in-person courses. This finding emphasizes the importance of physical presence for laboratory-based engineering courses [20]. The impact of online learning on African American students taking engineering technology courses remains largely uninvestigated. Although there is an increasing body of literature on the use of online learning in engineering education [21-24], little research has been conducted specifically on the effects of online learning on African American engineering technology students. A study for increasing the number of African American students in Engineering fields found that African American students in engineering courses had lower completion and success rates than their White peers [25]. The study authors attributed this disparity to factors such as limited access to technology and resources, as well as the need for increased support and guidance for African American engineering students.

Other studies have focused on the impact of online learning on students' academic performance and satisfaction. The results indicate that students' academic performance and satisfaction are influenced by the difficulty level of the course, the availability of resources, and the ease of use of the online learning platform [26-29]. Furthermore, research has found that students are more successful and satisfied in online courses when there is a sense of community and personal interaction.[30-33].

This study aims to expand on previous research into the effects of distance learning on African American students enrolled in engineering courses and the digital divide they face. It will specifically focus on the impact of distance learning on African American students taking laboratory-based engineering technology courses during the COVID-19 pandemic. The study will compare the academic performance and satisfaction of students who took the course in-person to

those who took it remotely. The results will provide valuable information on how to effectively deliver laboratory-based engineering technology courses to African American students in a distance learning environment. This will help address the challenges of delivering hands-on, experiential learning online and provide insight into the impact of distance learning on minority students in laboratory-based engineering courses. The findings will inform the viability of distance learning as a solution for laboratory-based engineering education.

Research Procedures

Florida A&M University (FAMU) is a historically black public university with a land-grant status. The Engineering Technology Division at FAMU has two programs: Construction Engineering Technology (CET) and Electronic Engineering Technology (EET), both of which have more than 90% African American students. Additionally, more than 70% of students are first-time in college and come from low-income families, with over 80% of undergraduates working part-time. Both programs are ABET-accredited and offer four-year undergraduate degrees. These programs follow a hands-on laboratory-based approach to teaching and have an average 10:1 student-faculty ratio in their core courses.

Prior to the COVID-19 pandemic, all the courses in both programs were offered in-person. FAMU has adapted Canvas as a learning management system tool, which can facilitate course instruction, communication, sharing of materials and recorded lectures, discussion forums, and design and management of assessments, assignments, and grades. During the pandemic, faculty had to adapt their traditional course material to suit online teaching through Zoom. FAMU provided infrastructure such as laptops, desktops, headphones, and graphics drawing tablets to faculty to ease this transition. The university also gave students laptops if they requested them. The Office of Instructional Technology at FAMU provided technical support and instructions to prepare and upload instructional materials on Canvas and deliver online lectures through Zoom. Despite these measures, students and faculty faced various challenges during online instruction in Spring 2020.

The study aimed to examine the impact of distance learning on African American students enrolled in laboratory-based engineering technology courses during the pandemic. It used a convergent parallel mixed-methods design, including quantitative and qualitative data collection methods. The study involved 49 students enrolled in the EET and CET programs over three semesters. Students in each program were divided into two groups: one group took the course in-person, and the other group took it through distance learning. The selected courses were Introduction to Robotics and Introduction to Robotics Laboratory for EET and Strength of Materials and Strength of Materials Laboratory for CET.

To measure academic performance, students' final grades in the selected courses were used. To assess student satisfaction, students were asked to take surveys exploring student background and course-related variables. The survey consisted of 32 questions in three sections: student demographics, course-related information, and in-person vs. distance learning experience. The questions asked about students' motivation in taking distance vs. in-person classes, ease of using the internet, work-life balance, guidance and communication from the instructor, satisfaction regarding resources available on Canvas, satisfaction regarding the instructor's availability, teaching, and class engagement, and class performance satisfaction for both lecture and laboratory. The survey instrument was validated through exploratory factor analysis.

Results

The surveys for EET courses were conducted at the end of Spring 2020 (courses went entirely in the distance-learning modality in March 2020), Spring 2021 (a hybrid option was offered, where students can choose to come to class or take the course online. Students had to adhere to their modality for the entire semester) and Spring 2022 (in-person modality). The student surveys for CET courses were conducted in Spring 2021 (hybrid), Spring 2022, and summer 2022 (hybrid). A total of 49 students took the survey. From CET, 27 students completed the survey, while from EET, 22 students completed the survey. The class sizes in each program are smaller; therefore, these numbers are justifiable for the programs. All the students who took the survey were either juniors or seniors. The data provided in the study presents the experiences of students in different aspects of distance learning and in-person classes.

The data shows the demographic characteristics of the sample used in the study. The gender distribution shows that out of the 49 participants, 42 were male, 5 were female, and 2 preferred not to say. This indicates that the sample was predominantly male. The income level distribution shows that out of the 49 participants, 29 were in the medium-income bracket, 17 were in the low-income bracket, and 3 were in the high-income bracket. This indicates that the majority of participants came from a medium-income background. The ethnicity distribution shows that out of the 49 participants, 44 were Black or African American, 3 were White, 1 was of another ethnicity, and 1 preferred not to say. This indicates that the sample was predominantly Black or African American.

These demographic characteristics provide important information about the sample and help to contextualize the study findings. For example, the overrepresentation of male participants and the predominant Black or African American ethnicity may impact the generalizability of the study findings to other populations. Understanding the demographic characteristics of the sample is important for interpreting the results of the study and for informing future research in the area. The study did not specifically focus on gender differences, so the impact of gender on the results is unclear. Nonetheless, future research could explore potential gender differences in the effects of distance learning on African American students in engineering technology courses during the COVID-19 pandemic. However, it helps to understand that these findings are factual for low-income, male African American students. The pie chart in Figure 1 shows the financial background of the participants in this survey.

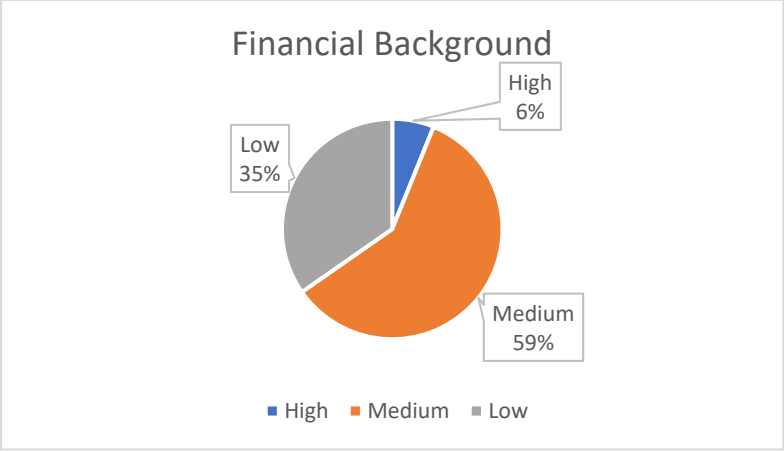

Figure 1: Financial Background of the Participants

Student Learning Challenges

The data provided in the survey results presents the experiences of both distance learning and in-person students in different aspects of their courses. The results show that both groups of students reported challenges and comfort levels in various aspects of their learning experiences. Distance learning students reported higher levels of difficulty maintaining focus during classes and lack of motivation, while in-person students reported lower levels in these areas. In-person students reported higher levels of comfort with using the internet and canvas for learning purposes, zoom and canvas comfortability, level of engagement in classes, and comfortability of interacting with peers. On the other hand, distance learning students reported higher levels of ease of work-study balance, ease of submitting assignments or exams online, ease of submitting lab assignments online, helpfulness of course-related resources on Canvas, and overall motivation level compared to in-person students.

The results presented in Figure 2 highlight the need to provide appropriate resources and support to distance learning students, particularly in time management and access to helpful equipment. The findings suggest that while distance learning students find it easier to submit assignments or exams online and are comfortable with turning their cameras on during online classes, they struggle with managing their time during online exams and need more support with university equipment. This suggests that institutions should ensure that distance learning students have access to reliable equipment and provide them with the necessary support to manage their time effectively.

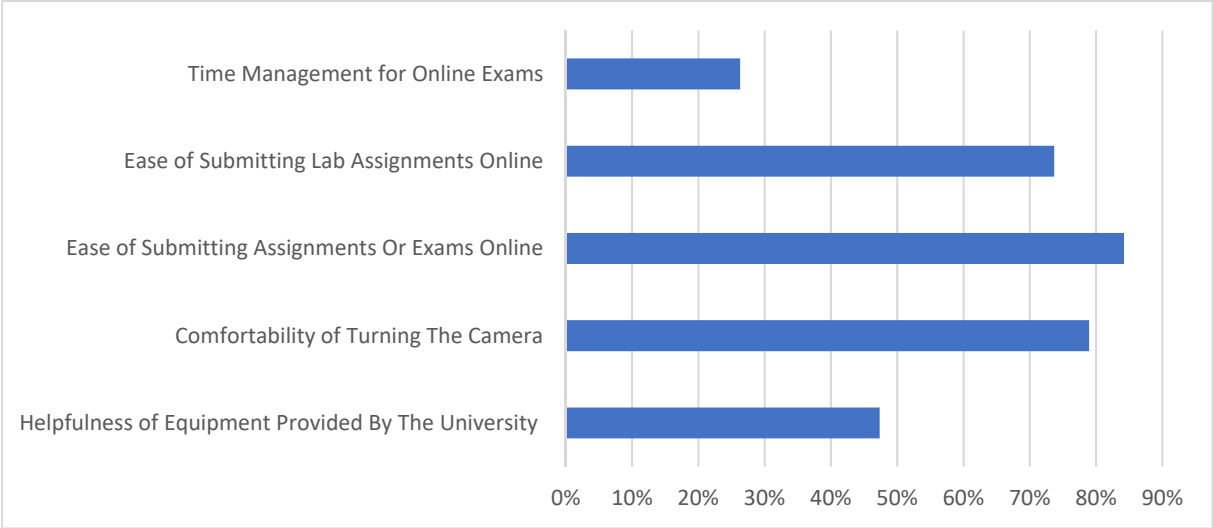

Figure 2: Student Responses to Challenges in Distance Learning

Figure 3 compares the responses of distance learning and in-person students to various challenges in their courses. The results suggest that while both groups face similar challenges, such as balancing work and studying, lack of motivation, and difficulty focusing during classes, distance learning students experience higher levels of these challenges. On the other hand, in-person students reported higher levels of comfort with using Canvas and Zoom, level of engagement in classes, and comfortability of interacting with peers. The results highlight the need to design course materials and delivery modes that provide students with the necessary support and resources to overcome these challenges.

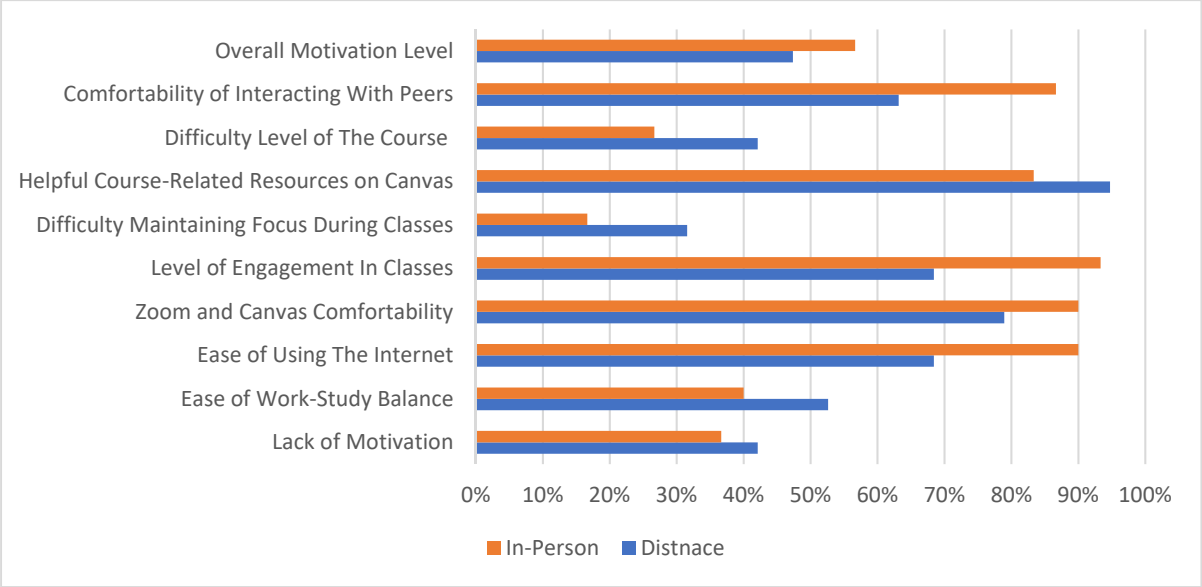

Figure 3: Responses to Challenges in Distance Learning vs. In-person Learning

Overall, the results presented in this study provide valuable insights into the experiences of distance learning and in-person students in different aspects of their courses. The findings suggest that both modes of course delivery have their unique challenges and comfort levels. To improve the overall learning experiences of students, institutions should develop effective strategies to support students in both modes of course delivery. The findings presented in this study can serve as a basis for further research into the design of effective support mechanisms for distance learning students.

Academic Performance and Student Satisfaction

The results of the study provide insight into the satisfaction levels of students in various aspects of the course, both for distance learning and in-person students. The findings reveal that while satisfaction levels were similar for both groups in some aspects, such as satisfaction with the amount of guidance and communication received from instructors and final grade satisfaction, distance learning students were more satisfied with the accessibility of instructors, whereas in-person students were more satisfied with the quality of laboratory experiments. Specifically, 9 distance learning students and 15 in-person students were extremely satisfied with the course overall, and 8 distance learning students and 9 in-person students were somewhat satisfied.

Regarding accessibility to instructors, 13 distance-learning students reported that their instructors were always accessible, compared to 21 in-person students. Satisfaction with the amount of guidance and communication received from instructors was similar for distance learning and in-person students, with 12 distance learning students and 20 in-person students extremely satisfied. In terms of satisfaction with the quality of laboratory experiments, 14 in-person students reported being extremely satisfied, compared to 7 distance learning students. However, satisfaction levels for final grades were similar for both groups, with 14 distance learning students and 16 in-person students being extremely satisfied.

Figure 4 displays the levels of student satisfaction in various aspects of their courses, showing that distance learning students reported higher satisfaction levels in most aspects, including satisfaction with the course (89% vs. 80%), accessibility of instructors (100% vs. 93%), and satisfaction with the amount of guidance and communication received from instructors (89% vs. 90%). In contrast, in-person students reported higher satisfaction levels with the quality of laboratory experiments (83% vs. 63%) and final grades (70% vs. 89%). These findings suggest that while distance learning may provide more access to instructors and support, it may face challenges in providing quality laboratory experiences and performance evaluation.

Educators and administrators can use these findings to develop strategies for improving the quality of laboratory experiences in distance learning and in-person classes, as well as enhancing performance evaluation for distance learning students. Additionally, they can focus on addressing the challenges faced by both distance learning and in-person students to enhance overall student satisfaction and learning outcomes.

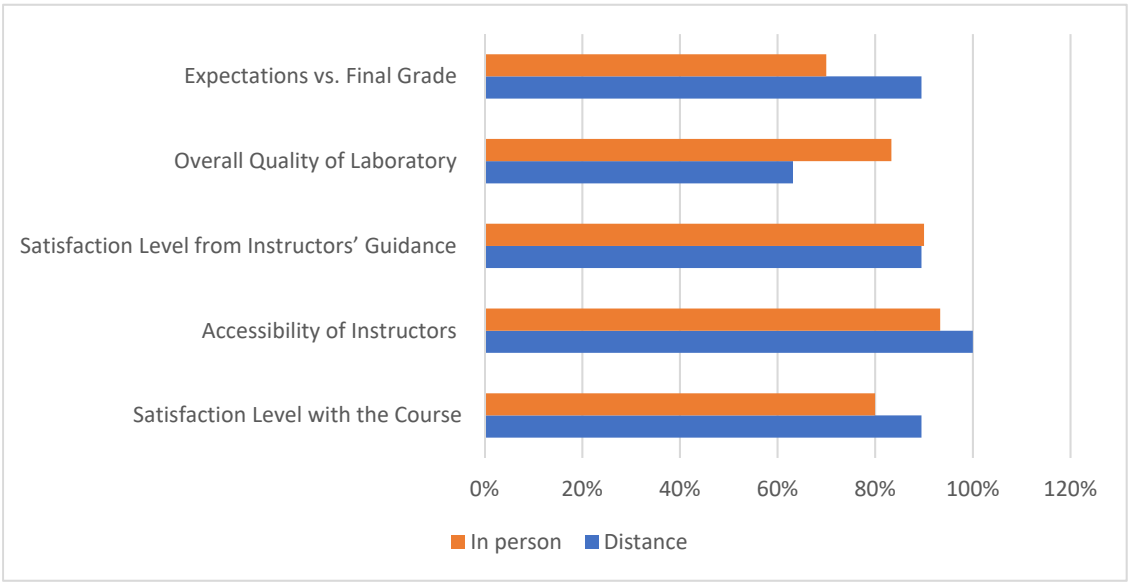

Figure 4: Student Performance and Satisfaction in Distance Learning vs. In-person Learning

Discussion

The results of this study provide valuable insights into the experiences of African American students in laboratory-based engineering technology courses during the COVID-19 pandemic, specifically in the context of distance learning. The data show that there were no significant differences in academic performance between students in distance learning and in-person courses, which is consistent with previous research in online education. Overall, the satisfaction levels were similar for both distance learning and in-person students in most aspects of the course, including satisfaction with the course overall, the amount of guidance and communication received from instructors, and final grade satisfaction. However, there were some notable differences in satisfaction levels between distance learning and in-person students.

Distance learning students reported higher levels of satisfaction with the accessibility of instructors, with more distance learning students reporting that their instructors were always accessible compared to in-person students. This finding suggests that distance learning may provide more opportunities for students to interact with their instructors, which can be beneficial

for their academic success. In contrast, in-person students reported higher levels of satisfaction with the quality of laboratory experiments, which is not surprising given that laboratory-based experiences are challenging to deliver online. However, it is important to note that this difference in satisfaction levels did not translate to a significant difference in academic performance between the two groups.

These findings have important implications for the delivery of laboratory-based engineering technology courses in the future. Distance learning can provide greater access to instructors and support, which can be particularly beneficial for students who come from low-income backgrounds and may not have easy access to resources. However, there are still some challenges in providing quality laboratory experiences and performance evaluation in a distance learning environment, which suggests that a hybrid approach that combines in-person and distance learning may be the best option for these courses. Overall, this study highlights the importance of considering the experiences of minority students in online education and the potential benefits and challenges of distance learning in laboratory-based engineering technology courses. Further research is needed to explore the impact of distance learning on other demographic groups and to identify best practices for delivering laboratory-based experiences online.

Conclusions and Recommendations

In conclusion, this study provides valuable insights into the experiences of African American students in laboratory-based engineering technology courses during the COVID-19 pandemic, particularly in the transition from in-person to distance learning. The findings suggest that while distance learning may provide more accessibility to instructors and support, it may face some challenges in providing quality laboratory experiences and performance evaluation.

The recommendations arising from this study include the need for greater support and resources for African American students in laboratory-based engineering technology courses, particularly in the areas of access to technology and resources, as well as the need for more guidance and communication from instructors. Additionally, institutions should explore ways to enhance the quality of laboratory experiences in the context of distance learning. This could include innovative strategies for simulating laboratory experiences, as well as providing students with relevant laboratory equipment to enable at-home experimentation.

In terms of future research, it is recommended that studies examine potential gender differences in the effects of distance learning on African American students in engineering technology courses during the COVID-19 pandemic. Additionally, future studies could explore the potential impact of distance learning on other underrepresented minority groups in engineering technology courses. Such studies could provide insights into the potential benefits and challenges of distance learning in enhancing access to engineering education for these populations.

Overall, this study contributes to a growing body of research on the impact of distance learning on African American students in laboratory-based engineering technology courses and underscores the importance of addressing the challenges of providing hands-on, experiential learning in the context of distance learning. By implementing the recommendations arising from this study, institutions can help ensure that African American students in laboratory-based engineering technology courses receive the necessary support and resources to succeed in their education and future careers.

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