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Bend and not Break: Examining Hispanic Engineering Student's Academic Challenges During Covid-19

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Student success in higher education remains an area of interest, particularly for underrepresented minorities. Studies reveal that while Latino college enrollment has increased, retention rates continue to be an ongoing struggle. Several factors that attribute to such low rates include academic self-concept, family support, cognitive mapping, managing resources, background characteristics, and separation and maintenance of family ties. In the wake of COVID-19, most institutions responded by terminating in-person instruction, mandating to seek off-campus housing, and shifting to a fully remote context. As such, students were unable to utilize campus resources and engage in established educational campus practices. In this research study, the authors aim to understand academic/personal experiences and challenges during the period of remote instruction that would provide value input to the factors that may attribute to 1) the low retention rates in engineering education, 2) racial and gender factors related to STEM degree attainment, and 3) low number of minorities in the STEM workforce and graduate school. This study further stems from the overall research objective of the authors which is to increase retention rates in engineering education, enhance academic preparation, and to increase the number of minorities in STEM fields and graduate school. students enrolled two engineering courses in a public, minority-serving institution in Texas - which resumed to face-to-face modality - were surveyed. Results indicate that the transition to remote instruction was challenging due to mental health factors, lack of motivation, family concerns, difficulty paying attention during lecture, and lack of communication/interaction with faculty members. Students further expressed that campus resources and classroom interaction were missed. These challenges consisted of concentrating on schoolwork, mental health issues, finding an adequate place to study and lack of technology and resources to complete assignments. The same students were hesitant to request certain accommodations to assist in their learning for fear of portraying themselves as struggling with material. Students also experience an overall lack of motivation to continue attending lectures remotely, one that persisted for many upon return to in-person instruction.

I. BACKGROUND AND MOTIVATION

For the past decades, efforts to establish systematic initiatives to nurture a strong STEM workforce pipeline has been a central topic of national educational reform debates [31]. The national commitment to promoting STEM excellence was evidenced by the State-Federal STEM Education Summit. The STEM Education Summit convened a wide range of STEM leaders from all 50 states, five territories, and several tribes. The goal of the summit was to outline and develop a national STEM education plan that "will to help inform the development of the upcoming Federal 5-Year STEM Education Strategic Plan" (p.3). To help support the initiative to enhance STEM education, the U.S. Department of Education allocated a $279 million dollars in discretionary funds for Fiscal Year 2018.

While federal, state, and district initiatives have created and implemented policies designed to bolster STEM achievement, there are numerous concerns that prove to be challenging in formulating effective solutions. One concern regarding the exponential growth of STEM-related occupations is the challenge for educational institutions to assist in meeting the demand of these growing fields. Post-secondary institutions have a responsibility to attract, retain, and develop

STEM talent that will advance and promote national economic interests and prosperity. Though significant efforts have proliferated, certain issues such as student attrition, access, and equity continue to play a major role in advancing STEM excellence and developing STEM talent. An area of major improvement is overcoming high **attrition rates** of students majoring in STEM disciplines. Data from the National Higher Education Research Institute (2010) revealed that more than half of students who declared majors in STEM related fields, as an incoming student, do not achieve STEM degrees.

Since the emergence of COVID-19, engineering departments across the country continue to struggle with retention rates. According to [retention] rates from Texas Public Universities, The University of Texas Rio Grande Valley, for instance, has an average freshman retention rate of 75%, which is relatively low compared to institutions across the state such as UT Austin (95%), Texas A&M University (92%), UT Dallas (88%), and the University of Houston (85%), but higher than many other institutions. For an undisclosed public university in Texas, statical measures indicate that retention rates of first year (full-time) students have been at an average of 60% between the Fall of 2015 and Fall 2019. However, it is observed that during the Fall of 2020, which includes the academic year during COVID-19, retention rates of incoming students fell to 53.3%, while retention rates within that institution also dropped to 60.9%. Further, passing rates in introductory courses in such undisclosed institution have significantly dropped during the pandemic. For instance, Introduction to Civil Engineering had passing rates in the Fall 2019 and Spring 2020 of 84.4% and 91.9%, respectively. However, this past academic year, which was surrounded by COVID-19, the passing rates fell significantly to 69.9% in Fall semester and 63.1% in the Spring semester. Similarly, the passing rates in Introduction to Electrical Engineering fell significantly from 75% in the Fall 2020 to 39.2% in the Spring 2021 semester.

These statistics become concerning when examining the racial and gender factors related to STEM degree attainment. Though progress has been made, a considerable gap remains between underrepresented groups such as Black and Hispanic students and their white counterparts in attaining STEM degrees. According to data provided by National Science Board, from 2000 and 2015, the number of science and engineering degrees awarded to Hispanic students has increased from 7% to 13% compared to 61% awarded white students [29]. These minor trends significantly impact the professional and career trajectories of students, but limit the diversification of the STEM workforce. For example, according to Pew Research Center Black and Hispanic groups continue to be underrepresented in STEM fields [30]. Today the Black community compromises 9% of all STEM workers, while 7% of the total STEM population is represented by the Hispanic community. Moreover, The Pew Research Center studied perceived reasons why women Blacks, and Hispanics are not pursuing STEM fields [30]. They concluded that 42% of such demographic groups do not pursue STEM fields given their lack of access to quality education, while 41% stated they were not encouraged to pursue STEM from an early age.

II. PROPOSED WORK

II.1 Purpose of Research

In this research study, the authors aim to understand academic/personal experiences and challenges during the period of remote instruction. This study would provide value input to the long-term research objectives of addressing 1) the low retention rates in engineering education, 2) racial and gender factors related to STEM degree attainment, and 3) low number of minorities in the STEM workforce and graduate school (Table 4). As such, the purpose of the research study is to identify

whether the academic challenges experienced by minority students during COVID-19 – in a Hispanic-Serving Institution (HIS) – attribute to two critical factors: 1) personal, or 2) academic factors.

II.1.1 Objective 1: Personal Challenges

A goal of this study is to identify personal challenges of the student population from the University of Texas Rio Grande Valley (UTRGV). On September 1, 2015, UTRGV became the newest university in the state of Texas and one of the newest universities in the United States. It consolidates the former University of Texas-Pan American (UTPA) with the University of Texas at Brownsville (UTB), and established a new school of medicine in Harlingen, thus, forming UTRGV, which now spans, with its distributed campuses, the entire Lower Rio Grande Valley.

Table 1. UTRGV Overview and Fast Facts (Source: Institutional Summary: www.utrgv.edu)

Background	Established 2015	General academic institution with a medical school of UT System
Primary Service Region	Rio Grande Valley (Cameron, Hidalgo, Star, & Willacy Counties	92.7% students from RGV RGV Population – 1.3+ million First Generation – College (UTPA, Fall 2014)
Current Enrollment Fall 2020	32,441 students	Undergraduate students 85% Full time 79%, Female 58% ~12% Engineering, ~12% Science
Ethnic Enrollment	88% Hispanic (Fall 2020)	Largest number of Hispanic students among Texas universities
Graduation Rate	24%-4-year (Fall 2020)	46% - 6year (Fall 2020)
Financial Aid	84.6% on some form of Financial Aid	Pell Grants – 65% undergraduates

UTRGV is now the second largest federally certified HSI of higher education in the United States, with a student population of more than 32,000, almost of 90% of whom are Hispanic, mainly Mexican-American due to the region's proximity to Mexico. UTRGV is an evolving multi-campus institution of higher education. In addition to combined and new resources, the university also houses a new School of Medicine, which enrolled its inaugural cohort Fall 2016. Table 1 shows an overview of the recently established UT System institution in the Rio Grande Valley (RGV). UTRGV has implemented different initiatives to increase the retention and graduation rates (shown in Table 1).

The RGV service area of UTRGV encompasses the four counties on Texas' southernmost border with Mexico including Cameron, Hidalgo, Starr, and Willacy counties. Approximately 93% of UTRGV students are residents in one of the four counties (~61% from Hidalgo County, ~28% from Cameron County, ~3% from Starr County, and ~1% from Willacy County).

The need for the proposed project is based on three key characteristics of the region (Table 2):

- Rapidly Growing Population: In terms of population, Table 2 shows that Hidalgo County (the largest county in the RGV) is growing at a faster rate than the USA.

- Very Young Population: The U.S. Census Bureau also reports that the percentage of RGV residents below the age of 18 is more than 30%. This percentage represents more than 400k residents in a four-county area who are less than 18 years old.
- Low Education Attainment and High Poverty Rates: Table 3 dramatically illustrates the low level of educational attainment and the high rates of poverty of the residents of the RGV (two largest RGV counties) when compared to the rest of the population of the United States.

Table 2. RGV Background Information (Source: http://quickfact.census.gov)

	USA	**Hidalgo**	**Cameron**
Population in 2019 (estimate)	328,239,523	868,707	423,163
Population, percent change April 2010 to July 2019	6.3%	12.1%	4.2%
People under 18 years old in 2019	22.3%	32.1%	29.9%
People age 25+ with HS or higher/ Bachelor's degree or higher in 2015-19	88% / 32.1%	65.7% / 18.7%	68% / 17%
Median household income, 2015-2019	$62,843	$40,014	$38,758
People below poverty level	10.5%	26.9%	25.5%

Statistical measures (Table 3) are consistently and significantly below national average and collectively impact life quality outcomes and educational interests for youth and families. These indicators include high concentration of poverty rates, low educational attainment, and standards of inhabitants, historically underserved area with limited access to quality educational resources and programs.

Table 3. Social and Economic Factors of the Rio Grande Valley

Social and Economic Factors	**RGV**	**Texas**	**United States**
Children Eligible for Free/Reduced Price Lunch	85.26%	58.94%	52.61%
Population Below 200% of Federal Poverty Level	59.85%	37.22%	33.61%
Children Below 200% of Federal Poverty Level	70.56%	48.22%	43.29%
Population with Bachelor's Degree or Higher	16.67%	28.10%	30.32%
Population with Associate's Degree or Higher	21.73%	34.89%	38.49%
Income - Per Capita Income	$15,142.00	$27,828.00	$29,829.00
Per Capita Income by Hispanic/Latino	$13,512.00	$16,640.00	$17,323.00
Per Capita Income by Non-Hispanic/Latino	$31,602.00	$34,871.00	$32,450.00

II.1.2 Objective 2: Academic Challenges

The second objective of this study is not to only understand the personal challenges experienced in HSI's, but also to examine the academic challenges, particularly since the emergence of COVID-19. It is believed that several academic challenges attribute to the learning environment established by faculty members during online instruction. According to the literature, classroom environment, which alludes to the tone, climate, or ambience influencing the setting, has an impact on student engagement, success, and learning in engineering education [5], [14], [15], [16], [17]. It is informed that educational productivity depends on the psychosocial aspect of the classroom, which is a combination of psychological factors and the social environment [11], [12], [13], [23], [24], [25], [26].

Numerous communication models and strategies have been designed and implemented given their educational benefits for in-person and remote instruction. For instance, a model termed ECNQ (acronym for Engage, Communicate, Names, Questions) was designed and implemented to engage students in the engineering classroom and disrupt traditional teaching practices [14]. Similarly, a model termed CIRE (e.g., acronym for Communication, Initiation, Reduction, and Extension), in which an instructional template was recommended for online instruction [15].

Though numerous communication models have generated favorable outcomes in terms of fostering student-instructor interaction, student collaboration, and establishing active learning environments, oftentimes barriers are indirectly established that hinder communication between students and faculty members. Several which include the absence of a well-structured curriculum, insufficient motivation to disseminate content, lack of clarification on abstract topics, or even unwillingness to establish communication channels outside the classroom.

II.1.3 Focus of Research Study

In this regard, the study aims to understand the following student experiences:

1. Transition to online instruction during COVID-19
2. Relevant changes from in-person to online instruction
3. Communication with instructor
4. Difficulties with assignments
5. Attendance to online lectures
6. Benefits of remote instruction
7. Campus resources
8. Difficulties adapting to in-person instruction

II. 2 Long-term Research Objective

This study further stems from the long-term research objective of the authors which is to increase retention rates in engineering education, enhance academic preparation, and to increase the number of minorities in STEM fields and graduate school. These objectives are believed to be attained by identifying the personal and academic challenges experiences by minority students from underserved communities, particularly during COVID-19.

Table 4. Long-term Research Objective

1. Pedagogical Methods, Academic and Personal Factors	2. Acquaint Faculty Members	3. Faculty Implementation of Effective Methods and Practices
Identify Effective Methods and Practices	Workshops	Increase retention rates in Engineering fields
Design and Implement Instructional Methods	Inform of Challenges with Students	Enhance academic preparation
Identify Personal and Academic Factors	Inform of Instructional Methods and Practices	Increase minorities in STEM fields and graduate school

III. METHODS AND ANALYSIS

For this study, a total of thirty-four students enrolled two engineering courses at The University of Texas Rio Grande Valley were surveyed by means of understanding academic/personal experiences and challenges during the period of remote instruction that would provide value input to the long-term factors that may attribute to 1) the low retention rates in engineering education, 2) racial and gender factors related to STEM degree attainment, and 3) low number of minorities in the STEM workforce and graduate school. The survey was administered to sophomores and juniors pursing Mechanical Engineering at the end of the semester, which were invited orally during class and via email.

In this context, a small, a self-developed survey was generated as the primary data collection method. It is noted that descriptive statistics were employed for analysis and presentation of data results. Nonetheless, the study poses the following limitations: (a) small sample size; (b) self-developed survey instrument; (c) convenient sampling procedure. To further enhance the findings of the study, it would have been beneficial to include various courses across engineering departments.

The authors utilized open coding to organize data into categories. According to Creswell, open coding "involves taking data and segmenting them into categories of information" [32]. While all the data gathered from the survey provided useful information, the open coding process was repeated multiple times to slowly reduce the number of categories that became the major themes for each. Participants were asked the following open-ended questions:

1. My transition to online instruction during COVID-19 was:
2. When you transitioned to online instruction during COVID-19, what changed the most from the in-person format? Select all that apply
3. During online instruction, did you contact your instructors asking for accommodations (e.g., additional time) on assignments?
4. During online learning, did you find it difficult to submit assignments on time?

5. How would you describe your attendance to online lectures? If you stopped attending, tell us why.
6. What are the benefits, if any, of remote instruction? Select all that apply
7. What did you miss the most about being on campus? Select all that apply (use)
8. Now that you are back on campus, what has been the most difficult aspect for you?

Below summarizes the guiding questions participants were asked to discuss with the researcher as well as an intra discussion within their respective teams.

IV. RESULTS

Student Participant Responses

Summary of Findings

IV.1 Summary of Feedback and Guiding Question One. The worldwide lockdown of businesses, industries, and federal agencies that were implemented and mandated to curb the spread of the virus generated a wide array of unique and fundamental challenges for organizations across the globe. One of those challenges included populations of students into overnight into "work from home" or remote learners. Such is the case with the present study and the ways in which students navigated from an on-campus experience to a completely virtual learning experience and back to in-person instruction. The first research question seeks to elicit free responses from students asking them to describe their transition to a complete virtual environment as seen below:

My transition to online instruction during COVID-19 was:

According to participant responses, the major themes emerging from the aforementioned guiding questions included:

- Difficulty concentrating including loss of focus
- Inadequate access to electronic devices to access instruction
- Unstable internet connectivity
- Mental health concerns and issues including anxiety and ADHD

The authors explore each of these themes in the following sections:

Difficulty Concentrating. The theme of difficulty concentrating and loss of focus which was a concern for the 57.0% of participants. One of the participants mentioned the transition to virtual was difficult in that they had trouble finding an adequate place for one hour of uninterrupted time living in a household of 5 or more individuals. Another participant mentioned the current COVID-19 pandemic as a major factor in not being able to concentrate: "Mental health, lack of motivation, harder to pay attention, and just sitting watching a computer screen for multiple hours on end took a tool." COVID-19 impacted every aspect of students' experiences.

Inadequate Access to Electronic Devices to Access Instruction & Unstable Internet Connectivity. The theme of not having adequate resources surfaced among 14% of all participants. One of the participants mentioned the transition to virtual was difficult in that they had difficulty with the required electronic devices to attend online lectures. Another participant mentioned the barrier of not having access to internet connectivity: "There was a lot of distractions and issues with internet connectivity." COVID-19 exacerbated the issues among rural, low-income, first-generation, college students including access to high speed internet which most students are able to access on campus.

Concerns Over Mental Health. The theme of mental health concerns surfaced among 29% of participants. One of the participants mentioned the transition to virtual was difficult in that they had issues with ADHD and all the distractions in their home. Another participant mentioned the how taxing it was being surrounded by people again: "It has been harder getting used to being surrounded by people again, especially for those of us with anxiety issues."

IV.2 Summary of Feedback and Guiding Question Two. For the guiding question, "When you transitioned to online instruction during COVID-19, what changed the most from the in-person format? Select all that apply." According to participants responses, the major themes emerging from the aforementioned guiding question included:

- Difficulty concentrating including loss of focus including the ability to learn the material
- Confidence in class

The authors explore each of these themes in the following sections:

Ability to learn the material. The theme of "My ability to learn the material" was a concern for the 90.9% of participants. This finding illustrates students' learning styles and preferences regarding the most effective way to engage and learn course material. It also highlights the challenges associated of adjusting rapidly to a new learning modality.

Confidence in Class. The theme of "Confidence in Class" was a concern for 75.8% of participants. This finding helps to highlight students' concern regarding their own self-efficacy to learn course material in this new learning setting. It can be argued that a large part of student's overall confidence in class originates from physically being in class, which ample opportunities to engage, interact, and socialize directly with both instructors and their peers.

IV.3 Summary of Feedback and Guiding Question Three. For the guiding question, "During online instruction, did you contact your instructors asking for accommodations (e.g., additional time) on assignments?" Students asked to select Yes or No. Those who selected No were provided a list of reasons for not requesting any form of accommodations. According to participants responses, 60.6% of the students indicated that they did ask their instructors for accommodations. The remaining students selected the following reasons for not requesting specialized instructional supports:

Student Reponses:

- 64.7% - Did not want to show that I was struggling
- 47.8% - Felt Intimidated

- 29.4% - I was working to support my family

IV.4 Summary of Feedback and Guiding Question Four. For the guiding question, "During online learning, did you find it difficult to submit assignments on time?" Students asked to select Yes or No. Those who selected No were provided a list to select certain reasons that contributed to their ability to submit assignments on time. According to participants responses, 66.7% of the students reported having difficulty to complete coursework on time. The main three reasons cited are listed below:

Student Reponses:

- 77.3% - I could not concentrate as much
- 72.7% - I struggled managing everything
- 72.7% - Had to watch lecture video

IV.5 Summary of Feedback and Guiding Question Five. For the guiding question, "How would you describe your attendance to online lectures? If you stopped attending, tell us why." Students were provided a total of four different item responses to select from. A total of 60.6% of participants indicated that they attended all lectures the entirety of the semester. One-third (33.3%) reported of attending early in the semester then gradually reduced the number of times doing so. To dig deeper into this outcome, students were asked a follow up question to learn more why they stopped attending online lectures. Below are the three highest selected reasons chosen by the participants:

Student Responses:

- 75.0% - Instruction was not the same as in-person learning
- 68.8% - I was not motivated to attend
- 56.3% - I did not understand anything from the lectures

IV.6 Summary of Feedback and Guiding Question Six. For the guiding question, "What are the benefits, if any, of remote instruction? Select all that apply." Students were provided a total of eleven different item responses to select from. These Below are the top three items selected by student participants:

Student Responses:

- 63.6% - Watch lectures at my own convenience
- 60.6% - Less financial burden
- 42.4% - I could work during the day and study in the evenings

IV.7 Summary of Feedback and Guiding Question Seven. For the guiding question, "What did you miss the most about being on campus? Select all that apply." Students were provided a total of 10 different item responses to select from. Being on campus does provide many benefits for students, particularly those from diverse backgrounds and possessing first generation status. Data collected revealed that 81.3% of the students selected 'classroom instruction and interaction with peers' as being what they missed most about being on campus. Below highlight the highest selected items by student participants:

Student Responses:

- 81.3% - Classroom instruction and interaction with peers
- 60.6% - Campus resources
- 65.6% - Friends

IV.8 Summary of Feedback and Guiding Question Eight. For the guiding question, "Now that you are back on campus, what has been the most difficult aspect for you?" The final survey question sought elicit free responses from students asking them to describe what difficulties they have experienced with transitioning back to in-person, on campus instruction.

According to participant responses, the major themes emerging from the aforementioned guiding questions included:

- Recovering motivation to focus on school
- Health and safety regarding Covid (i.e., wearing masks)
- Readjusting to in-person lectures

The authors explore each of these themes in the following sections:

Recovering motivation to focus on school. The theme of difficulty of recovering motivation to continue in school was a concern for several the students. One of the participants mentioned that the shift from fully remote to a hybrid learning environment has affected their ability to remain motivated and focused. They expressed this concern by sharing, "My motivation for those specific classes (online) is dwindling and I'm finding it more difficult to keep up with everything as my mental health is on and off again." COVID-19 disrupted students' ability to focus and concentrate on their studies, while challenging their motivation, thus undermining their confidence in themselves to be successful in a new learning reality.

Concerns over health and safety regarding Covid (i.e., wearing masks). The theme having concerns over health and safety regarding Covid was another theme that surfaced from the study. Several of the participants expressed concern over the possibility of becoming infected by COVID, which impacted their ability to experience a smooth transition to on campus learning. When asked what the most challenging aspect is of returning to campus, one student mentioned that "Wearing a mask most of the time so I have difficulty breathing while walking a lot around the campus and having the fear of taking it off because I don't know who could have COVID." The possibility of being infected with COVID and university policies required individuals to wear masks while on campus proved to be a challenging experience both physically and mentally for students.

Readjusting to in-person lectures and commuting. The theme of readjusting to in-class learning was another theme experienced by several participants. The differences between remote instruction and in-person learning are distinctive in nature and required students to make proactive, strategic efforts to adjust to a different modality of learning. One of the participants mentioned the difficulty of adjusting to in-person lectures, while another added the following: "It was difficult to adjust to online learning last year, but I believe it's been harder to adjust to in-person. Moreover, other students expressed challenges posed by returning to campus to resume in-person learning. One student noted: "The travel to and from school has been the most difficult. Now with all the construction as well as holiday traffic it takes me almost an hour to get to school from my home."

The readjusting process has proved to be difficult for many of the students and many are still struggling to navigate this new, but (un)familiar terrain.

V. CONCLUSION

The onset of COVID-19 was a disruptive force that dramatically changed the way traditional schooling operated. Both faculty and students were challenged to devise new ways of coping and adjusting to a new reality, making efforts to continue learning and teaching effectively, while trying to curtail the threatening effects posed by COVID-19. Unfortunately, COVID-19 did indeed have some negative and damaging effects to long-standing educational processes, systems, and modes of operation. Moreover, the virus had deeply impacted personal welfare, mental health, and economic outputs of many individuals. This reality becomes more concerning for first generation, low-income students of color, such as the ones that participated in this study. In this research study, the authors aim to understand academic/personal experiences and challenges during the period of remote instruction that would provide value input to the factors that may attribute to 1) the low retention rates in engineering education, 2) racial and gender factors related to STEM degree attainment, and 3) low number of minorities in the STEM workforce and graduate school. This study further stems from the overall research objective of the authors which is to increase retention rates in engineering education, enhance academic preparation, and to increase the number of minorities in STEM fields and graduate school. As such, understanding students' lived experiences is critical in establishing effective systems, programs, and processes that allow institutions to strategically tap into the talented pool of students from underrepresented and underserved communities, thus transforming the STEM workforce landscape.

Data from this study revealed unique and distinctive challenges encountered by students during remote instruction. These challenges consisted of concentrating on schoolwork, mental health issues, finding an adequate place to study and lack of technology and resources to complete assignments. The same students were hesitant to request certain accommodations to assist in their learning for fear of portraying themselves as struggling with material. Students also experience an overall lack of motivation to continue attending lectures remotely, one that persisted for many upon return to in-person instruction. Students also indicated that there were several benefits to remote instruction, one being linked to financial/economic reasons, such as reducing costs for community to school and having more time to work during the day. Though it was a welcomed change, the transition to on campus learning did present unique challenges to students. Regarding in-person instruction, students' concern centered around recovering motivation to focus on school, concern over health and safety readjusting to in-person lectures. In the midst of this change, uncertainty, and obstacles posed by effects of COVID-19, the students have displayed incredible character, grit, and a resolute spirit that can help catalyze creative solutions and generate a sense of hope needed in academia.

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