Factors Driving and Impeding STEM Student Motivations and Success

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Abstract

Fostering heightened interest and engagement in engineering, cultivating diversity, equity, and inclusivity within the engineering workforce, and equipping students to thrive in an industry characterized by rapid technological advancements stand as pivotal objectives in Science, Technology, Engineering, and Mathematics (STEM) education. Motivation exerts a profound influence on students across diverse academic fields. It is intricately intertwined with their level of engagement in the subjects they are studying, the inherent complexities of their chosen career paths, the career opportunities they foresee, and the potential of being misdirected toward a field they may not truly enjoy. To this end, understanding the key factors driving motivation is of the utmost importance, not only to increase retention and reduce attrition, but to also enhance students' learning, performance, and success. Even though the critical role of motivation in students' learning and overall academic success is widely acknowledged, there remains a notable gap in research examining the factors contributing to students' struggles in finding the necessary motivation for effective learning and outstanding performance, along with strategies to address this deficiency. This research aims to fill this gap by exploring the key factors driving STEM students' motivations for learning while simultaneously investigating the key factors hindering this motivation. To achieve these goals, this study surveyed STEM students at one of the largest minority-serving institutions in the United States to identify the key factors motivating and demotivating them, as well as to pinpoint strategies for enhancing motivation. The survey results revealed that several academic, financial, and social factors play a significant role in students' motivation, including career difficulty, perceptions of future and career opportunities, financial difficulties, lack of adequate work-life balance, and subsequent burnout. In light of these results, this research proposes several strategies that could potentially help students increase their motivation, including peer mentoring and/or tutoring, financial aid workshops, career fairs, and time management workshops. The findings of this study serve educational institutions and stakeholders by providing them with strategies that could help motivate students and contribute to their academic success.

Keywords: Academic Performance, Academic Success, Higher Education, Lack of Motivation, Retention, STEM Education, Students' Motivation

Background and Motivation

Low enrollment, inadequate academic performance, slow graduation rates, prolonged time-to-degree, poor retention rates, and high attrition among Science, Technology, Engineering, and Mathematics (STEM) students are critical concerns for higher education institutions [1], [2], [3], [4], [5]. Furthermore, the need for STEM graduates is consistently rising at a relatively fast rate [6]. Consequently, promoting greater interest and engagement, fostering diversity, equity, and inclusivity, and equipping STEM students to succeed academically and professionally in an industry characterized by swift technological advancements stand as crucial objectives in higher education.

Motivation is described as the process by which activities directed towards specific goals are initiated and sustained [7], [8]. As such, motivation exerts a profound influence on students across diverse academic fields, impacting their determination, curiosity, drive to learn, exertion of effort, perseverance, performance, and achievement of academic success [9], [10], [11]. It is intricately intertwined with the students' level of interest and engagement in the subjects they are studying, the inherent complexities of their chosen career paths, the career opportunities they envision, and the possibility of being directed toward a field they might not genuinely find enjoyable [10], [12], [13]. Student motivation challenges can manifest in both initiating and sustaining goal-related activities. While some students may struggle to start tasks or assignments due to factors like procrastination, lack of interest, or feeling overwhelmed, others may find it difficult to maintain their motivation and effort over time, facing issues such as boredom, fatigue, or distractions [7], [14]. To this end, understanding the key factors driving STEM students' motivation, as well as hindering their motivation, is pivotal to the academic community not only to increase retention, improve graduation rates, and decrease attrition, but also to enhance students' learning, performance, and prospects for academic and professional success.

To understand students' motivation, it is crucial to comprehend the reasons behind their behavior, what drives them to start, maintain, and stop their actions, how they approach tasks, and their confidence levels [9], [15]. Human behavior is driven by either intrinsic motivation, extrinsic motivation, or amotivation [8].

Intrinsic motivation (IM) involves participating in an activity for the inherent satisfaction it provides. As such, it arises from an individual's inherent satisfaction, interest, or enjoyment of a behavior or activity, without the need for external rewards [8], [13], [15], [16], [17], [18]. In an academic context, IM can be understood as a preference and drive for (1) knowledge, involving engaging in tasks for the joy and satisfaction of learning; (2) achievement, finding satisfaction in producing results or surpassing personal limits through accomplishing, creating, or striving to meet an optimal challenge; and/or (3) stimulating experiences, engaging in activities to encounter specific sensations, such as excitement, enjoyment, sensory pleasure, aesthetic appreciation, or the joy of being involved in the activity [8], [11], [17]. IM is linked to heightened levels of effort and task performance, along with a preference for challenges. As such, it plays a pivotal role in academic achievement and well-being [19], [20]

Conversely, extrinsic motivation (EM) stems from the pursuit of external incentives or outcomes, such as rewards or avoidance of punishments [8], [13], [15]. Consequently, an extrinsically motivated individual engages in an activity not for the activity itself but rather to obtain something enjoyable from it or to evade something unpleasant upon completing the activity [11], [17]. EM can be categorized into four subtypes according to their highest level of self-determination: (1) external regulation, where behavior is governed by external control sources, such as tangible rewards or constraints imposed by another individual, i.e., a student who studies because their parents insist on it; (2) introjection, where the individual internalizes external sources of control, or constraints, for the behaviors or actions, i.e., a student completing coursework due to a sense of guilt; (3) identification; where the behavior is perceived by the individual as a personal choice because it gained value and is deemed significant, i.e., a student doing coursework as a chosen means to learn; and (4) integration, where the individual reaches the highest level of self-determination and they sense autonomy in regulating a specific behavior,

i.e., a student who decides to study because that will help them succeed in the exam and thus in achieving professional success [11], [15], [17].

Finally, amotivation (AM) is characterized by a reduced intention toward goal-directed behavior. It indicates a broad absence of intrinsic and extrinsic motivation to participate in a behavior or activity [8], [13], [15], [17]. AM is often perceived in classroom environments and can result from either a perceived lack of competence to perform or a lack of value or interest in the subject [17]. It negatively impacts engagement, learning, and overall well-being [17].

Motivational challenges are widespread in education, and a significant source of frustration for many educators is the apparent lack of motivation observed in their students to learn and achieve academic success [8], [21]. However, despite the widely acknowledged critical role of motivation in students' academic and professional success, there is not much research published that investigates the factors that lead to students facing challenges in acquiring the motivation necessary for successful learning and exceptional performance, along with strategies to address this deficiency. This study aims to fill this gap by investigating the factors driving and hindering STEM students' motivation through surveying construction management (CM), civil engineering (CE) and other STEM students at one of the largest minority-serving institutions (MSIs) in the United States (U.S.). This research utilized the Academic Motivation Scale (AMS) to understand students' intrinsic and extrinsic motivators, as well as the factors related to their amotivation. The AMS, created by Vallerand et al. in 1989 [11], is one of the frequently utilized tools for assessing motivation levels related to learning and has demonstrated adequate reliability and validity in several studies [8], [9], [11], [15], [22], [23]. Furthermore, this study proposes several strategies aimed at helping students enhance their motivation for learning and success.

Methodology

This study is guided by three research questions: (1) What factors drive STEM students' motivation to learn and succeed academically? (2) What factors hinders STEM students' motivation to learn and succeed academically? And (3) what can be done to improve STEM students' motivation to learn and succeed academically?

This research addresses these three research questions through surveying CM, CE, and other STEM students at one of the largest MSIs in the U.S. to understand the factors driving and hindering the motivation of STEM students. For data collection, the study employed a purposive sampling approach. This method, known as judgmental sampling, entails selecting individuals for the sample based on the researcher's discretion regarding their perceived usefulness or representativeness within the population. This study employed a mixed-methods sequential explanatory design to collect and analyze both quantitative and qualitative data from students. The administered survey included a demographic section followed by four questions. The first question intended to identify whether students felt motivated to learn. The second question aimed to understand why students attended their academic institution. This question utilized the AMS, which consists of 28 comprehensive statements designed to assess students' motivation levels. These statements encompassed both intrinsic and extrinsic motivation elements, as well as factors related to amotivation. Students' responses were provided on a five-point Likert scale for each of the 28 statements. The Likert scale points were designated as follows: 1 = does not

correspond at all, 2 = corresponds a little, 3 = corresponds moderately, 4 = corresponds a lot, and 5 = corresponds exactly. Then, the mean and standard deviation were calculated. The third question sought to identify which factors were hindering students' motivation. The last question asked students to mention what the academic institution could do to enhance their motivation. Subsequently, the collected data was examined, which aided in the development of proposed strategies to improve students' motivation and their overall well-being. Figure 1 presents the research overview.

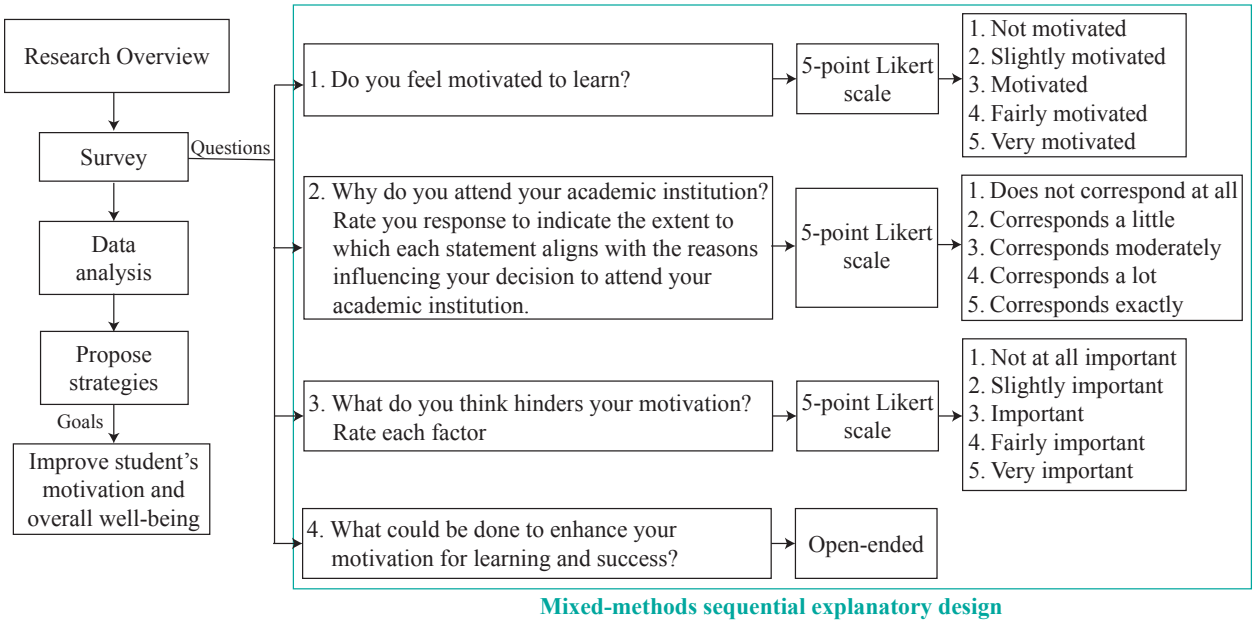

Figure 1. Research overview

Results

This section presents the results associated with the responses of 57 STEM students at an MSI. The research used a mixed-methods sequential explanatory design to collect and analyze quantitative and qualitative data from students. The recorded data included a diverse student group including (a) 38 students from CM, 13 students from CE, and 6 students from other STEM degrees; (b) 39 males, 13 females, two non-binary/gender fluid, and three students who preferred not to answer; (c) 29 international students, 18 local students, 7 transfer students, and 3 students who preferred not to answer; (d) students from multiple races, including White, Asian, African American, Latino, among others; and (e) 32 Hispanic and 20 non-Hispanic students. The socio-demographic background is presented in Figure 2.

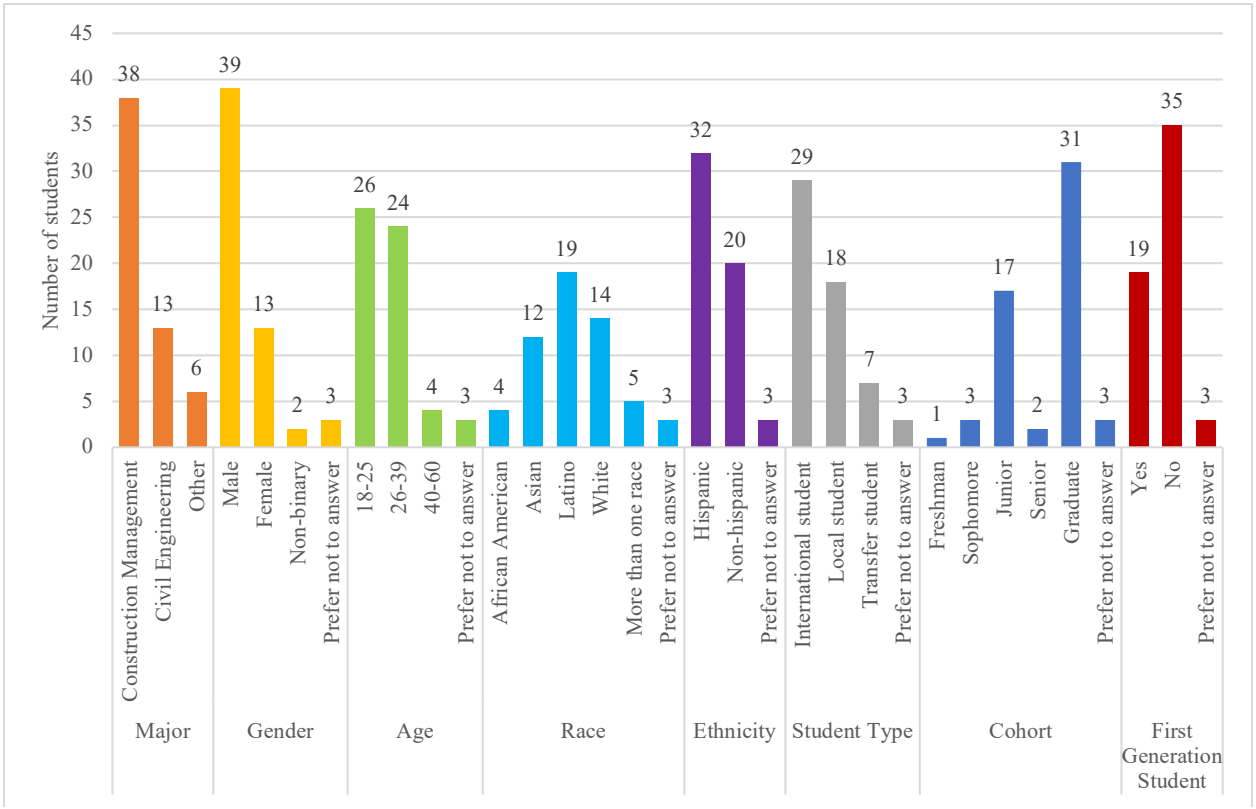

Figure 2. Students' Socio-Demographic Background, n=57

The first question intended to identify if students felt motivated to learn. According to the results of the survey, (1) only around 53 percent of students are very motivated to learn and succeed academically; (2) around 25 percent of students are fairly motivated, but not very motivated; and (3) more than 20 percent of students exhibit only mild or slight motivation towards learning. These results are presented in Figure 3.

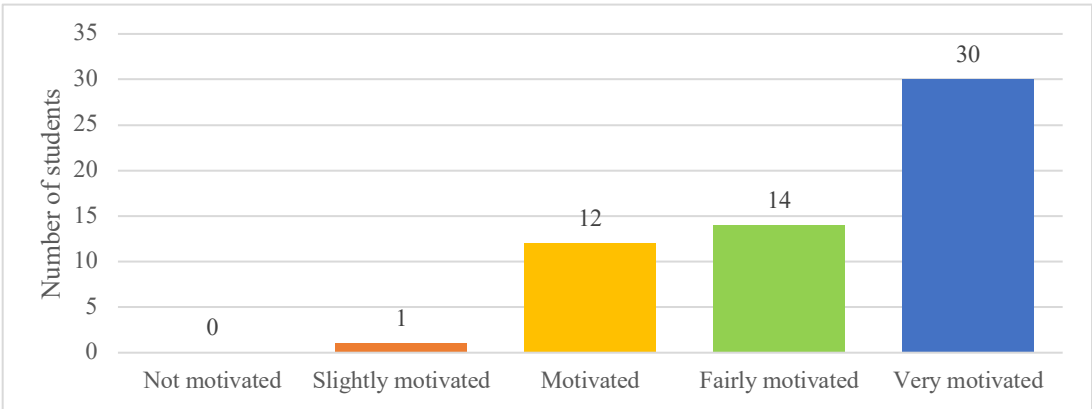

Figure 3. Students' motivation towards learning

The second question aimed to understand the reasons behind students attending their academic institution. To this end, the authors used the AMS scale, comprising (1) intrinsic motivation elements, including intrinsic motivation to know, intrinsic motivation toward accomplishment or achievement, and intrinsic motivation to experience stimulation; (2) extrinsic motivation

elements, including extrinsic motivation driven by identification, motivation influenced by introjection, and motivation stemming from external regulation; and (3) amotivation elements. The variables, motivation types corresponding to each of the variables, as well as the mean and standard deviation scores, are presented in Table 1. The highest mean motivation scores were observed in the following items (a) item 3, "Because I think that a college education will help me better prepare for the career I have chosen," with a mean of 4.32; (b) item 22, "In order to have a better salary later on," reflecting a mean of 4.32; (c) item 8, "In order to obtain a more prestigious job later on," registering a mean of 4.26; and (d) item 10, "Because eventually it will enable me to enter the job market in a field that I like," with a mean of 4.16. As it may be observed, all items displaying the highest mean values are associated with extrinsic motivation elements. Items 3 and 10 correspond to extrinsic motivation driven by identification, signifying that the behavior is seen as a personal choice with perceived value and significance. On the other hand, items 8 and 22 correspond to extrinsic motivation driven by external regulation, indicating that the behavior is influenced by external control sources, such as pursuing a better salary and obtaining a more prestigious job later on. Thus, it highlights that financial factors significantly impact students' motivation to attend college. Furthermore, these results highlight that intrinsic motivations, which play a pivotal role in the academic achievement of students, do not rank as primary sources of motivation for STEM students when it comes to attending college. Additionally, it is worth noting that all these items are career-related, thus underscoring the importance of focusing on professional development and career preparation in education.

Additionally, according to this study's results, the items with the lowest mean motivation scores include: (a) item 26, "I don't know; I can't understand what I am doing in school," with a mean of 1.23; (b) item 19, "I can't see why I go to college and frankly, I couldn't care less," reflecting a mean of 1.37; (c) item 5, "Honestly, I don't know; I really feel that I am wasting my time in school," registering a mean of 1.54; and (d) item 12, "I once had good reasons for going to college; however, now I wonder whether I should continue," with a mean of 1.77. All of these correspond to the amotivation elements of the scale, thus emphasizing that amotivation reflects the lowest values among STEM students.

Table 1. Students' responses to the Academic Motivation Scale

Item No.	Variables	Motivation Type	Mean	SD
1	Because with only a high-school degree I would not find a high-paying job later on.	Extrinsic Ext. regulation	3.3	1.31
2	Because I experience pleasure and satisfaction while learning new things.	Intrinsic To know	3.95	1
3	Because I think that a college education will help me better prepare for the career I have chosen.	Extrinsic Identified	4.32	0.96
4	For the intense feelings I experience when I am communicating my own ideas to others.	Intrinsic Stimulation	3.25	1.39
5	Honestly, I don't know; I really feel that I am wasting my time in school.	Amotivation	1.54	1.19

6	For the pleasure I experience while surpassing myself in my studies.	Intrinsic Accomplishment	3.33	1.23
7	To prove to myself that I am capable of completing my college degree.	Extrinsic Introjected	3.68	1.24
8	In order to obtain a more prestigious job later on.	Extrinsic Ext. regulation	4.26	1.02
9	For the pleasure I experience when I discover new things never seen before.	Intrinsic To know	3.91	1.06
10	Because eventually it will enable me to enter the job market in a field that I like.	Extrinsic Identified	4.16	1.01
11	For the pleasure that I experience when I read interesting authors.	Intrinsic Stimulation	2.93	1.18
12	I once had good reasons for going to college; however, now I wonder whether I should continue.	Amotivation	1.77	1.14
13	For the pleasure that I experience while I am surpassing myself in one of my personal accomplishments.	Intrinsic Accomplishment	3.86	1.03
14	Because of the fact that when I succeed in college, I feel important.	Extrinsic Introjected	3.26	1.41
15	Because I want to have “the good life” later on.	Extrinsic Ext. regulation	3.91	1.14
16	For the pleasure that I experience in broadening my knowledge about subjects which appeal to me.	Intrinsic To know	3.72	1.02
17	Because this will help me make a better choice regarding my career orientation.	Extrinsic Identified	3.98	1.05
18	For the pleasure that I experience when I feel completely absorbed by what certain authors have written.	Intrinsic Stimulation	2.77	1.2
19	I can’t see why I go to college and frankly, I couldn't care less.	Amotivation	1.37	1
20	For the satisfaction I feel when I am in the process of accomplishing difficult academic activities.	Intrinsic Accomplishment	3.47	1.3
21	To show myself that I am an intelligent person.	Extrinsic Introjected	2.96	1.39
22	In order to have a better salary later on.	Extrinsic Ext. regulation	4.32	0.86
23	Because my studies allow me to continue to learn about many things that interest me.	Intrinsic To know	3.95	1.03
24	Because I believe that a few additional years of education will improve my competence as a worker.	Extrinsic Identified	3.89	1.1
25	For the “high” feeling that I experience while reading about various interesting subjects.	Intrinsic Stimulation	2.81	1.41

26	I don't know; I can't understand what I am doing in school.	Amotivation	1.23	0.65
27	Because college allows me to experience a personal satisfaction in my quest for excellence in my studies.	Intrinsic Accomplishment	3.74	1.19
28	Because I want to show myself that I can succeed in my studies	Extrinsic Introjected	3.51	1.38

The third question sought to uncover the factors hindering STEM students' motivation to learn. The results from the 57 conducted surveys, presented in Figure 4, indicate that several factors play a significant role in hindering STEM students' motivation. The key contributing factors encompass (a) uninteresting courses and/or topics, (b) lack of work-life balance, (c) stress, anxiety, and/or other mental health issues, (d) teaching methods that are uninteresting and unengaging, (e) learning environment, and (f) class difficulty. Furthermore, students reported that financial issues and instability were significant factors hindering their motivation to learn. That said, it can be observed that academic, financial, and social factors play a significant role in students' motivation.

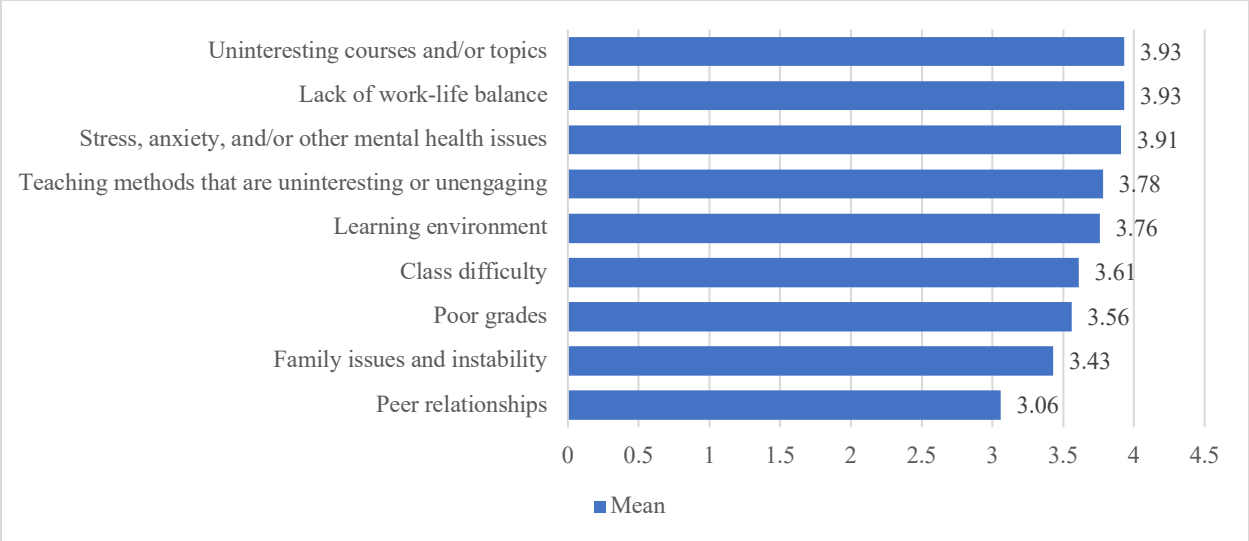

Figure 4. Factors hindering students' motivation

Finally, an open-ended question in the survey asked students to suggest ways in which the academic institution could enhance their motivation. The recorded responses highlighted several approaches that could enhance students' motivation, including: (a) fostering good professors and implementing engaging, interactive, and motivational teaching methods, incorporating hands-on experience, on-the-job training, problem-based learning, and real-world examples for effective learning; (b) continuous monitoring to ensure that professors and course content contribute to students' learning and professional advancement and success; (c) making classes more interesting and engaging, catering to students needs and strengths; (d) addressing financial concerns through financial aid, reduced tuition fees, and increased stipends for international students working at the academic institution; (e) introducing new and unusual topics to motivate and engage students; (f) providing mentoring and guidance, supporting students in areas of difficulty, and offering encouragement; (g) addressing social anxiety, stress, and depression, as

well as promoting work-life balance; (h) demonstrating the rewards associated with learning; (i) improving peer communication and collaboration, as well as facilitating opportunities for students to interact with professors in the same career field for mentorship advice; (j) eliminating courses unrelated to the chosen career; (k) providing insights into future career prospects and networking opportunities with industry professionals; (l) incorporating new technologies and regularly updating courses to stay current.

Limitations and Future Work

This study revealed the significance of motivation to learn and achieve both academic and professional success. One of the limitations of the study is that the survey responses might be affected by self-assessment and biases. Additionally, the research has been conducted at an MSI in the U.S., reducing its applicability to other educational institutions and impacting the scalability of the study. Nonetheless, this institution is one of the leading and largest MSIs in the U.S., thus rendering and reflecting the sample to be representative of the minority population. The recommendations provided are preliminary, and future research could explore additional demographics and engage a more diverse student population. Furthermore, future studies could explore if different cohorts, such as undergraduates and graduates, or student nationalities, such as international students and local students, have a significant impact on their motivations. This could contribute to a broader understanding and support a larger and more representative sample of students across various educational institutions.

Conclusions and Recommendations

The findings of this study revealed that several academic, financial, and social factors significantly influence students' motivation. Key motivating factors for attending college include (a) two extrinsic motivations driven by identification, linked to obtaining a job in the chosen career; and (b) two extrinsic motivations driven by external regulation, linked to achieving a better job and salary. Furthermore, several factors hinder students' motivation to learn, including (a) uninteresting courses and/or topics, (b) lack of work-life balance, (c) stress, anxiety, and/or other mental health issues, (d) teaching methods that are uninteresting and unengaging, (e) learning environment, (f) class difficulty, and (g) financial issues and instability. Finally, students suggested various approaches to enhance motivation, some of which include addressing financial concerns, implementing engaging teaching methods, providing mentoring and guidance, supporting students in areas of difficulty, promoting work-life balance, addressing social anxiety, stress, and depression, and providing networking opportunities with industry professionals to gather insights into future career prospects.

In light of these results, the authors proposed several strategies that could help increase STEM students' motivation:

1. **Financial aid workshops and counseling** – The results of this study highlighted that financial stress is a key factor hindering students' motivation. Furthermore, international students experience more financial stress than their non-international counterparts due to visa restrictions preventing them from working off-campus [24]. Financial health not only helps students improve their concentration and academic performance but also contributes to their

overall happiness and well-being [25], [26]. Financial aid workshops and counseling can help students explore available financial aid options, including scholarships, grants, loans, company funding, and federal work-study. Moreover, these sessions can impart valuable financial management skills, contributing to the overall improvement of students' financial health.

2. **Implementing engaging teaching methods** – Students reported that incorporating engaging, interactive, and motivational teaching methods, such as hands-on experience, on-the-job training, and problem-based learning, could be highly beneficial for effective learning and increasing motivation. Active participation in hands-on experience not only increases student interest and motivation but also improves critical thinking and fosters the development of knowledge and skills [27], [28], [29], [30]. Therefore, enhancing student learning and performance contributes to academic success. On-the-job training offers students work-based experience, enabling them to apply knowledge and skills in practical scenarios. This practical exposure is a significant pathway to early career employment [31], [32], [33]. The knowledge and skills acquired through work-based experience are key in preparing for professional practice [34]. Problem-based learning exposes students to real-world challenges, fostering critical thinking and enhancing analytical and reflective skills [35], [36]. This teaching method promotes active engagement, increases interest and motivation, and nurtures a culture of research [30], [35], [37], [38], [39].
3. **Mentoring, guidance, and academic advising** – The interaction between students and faculty not only fosters a positive academic climate but also significantly contributes to students' performance and success [1], [2], [40]. Academic advising can help students address fears and concerns related to academic performance and career goals, as well as assist students in integrating life, educational, and career goals [2]. Furthermore, peer tutoring and mentoring programs can assist students in better understanding areas of difficulty, teaching not only course content but also essential academic skills, such as study habits [5], [41]. Furthermore, an added benefit of these programs is creating a network of friends and support system, contributing to students' motivation and overall well-being.
4. **Providing networking opportunities with industry professionals** – Many students experience a prevailing sense of uncertainty about the future, significantly impacting their motivation levels. Offering networking opportunities, such as career fairs or workshops with industry professionals, where students can meet with employers, recruiters, organizations, and companies, would help them gather insights into future career prospects and think more clearly about their career paths [26], [42]. Students can explore diverse employment opportunities and career paths, as well as find employment opportunities in their chosen careers.
5. **Time management workshops** – According to the results of this study, a lack of an adequate work-life balance is one of the main factors hindering students' motivation to learn. Implementing successful time management strategies to foster an adequate work-life balance may reduce stress and anxiety, as well as improve academic performance and overall achievement [26], [43]. Time management workshops or seminars could assist students in acquiring effective time management skills, including goal setting, planning, organization, blocking out distractions, the ability to say "no" to non-essential tasks, and delegating responsibilities. Acquiring these skills would enable students to balance their academic, work, leisure, and personal lives, ultimately contributing to their motivation and enhancing their overall well-being.

6. **Wellness activities and workshops –** The findings of this study emphasized stress, anxiety, and other mental health issues as significant contributing factors that impede students' motivation. Incorporating wellness activities, such as yoga, meditation, and mindfulness, can significantly contribute to students' mental health, reducing anxiety, stress, and depression [26], [44], [45], [46], [47]. This, in turn, improve academic performance and overall well-being. Encouraging students to occasionally engage in these activities and promoting all available wellness resources within the academic institution can foster a culture of well-being and help students derive benefits from them.

References

[1] Y. Chen, A. Johri, and H. Rangwala, "Running out of STEM: A Comparative Study across STEM Majors of College Students At-Risk of Dropping Out Early," in *Proceedings of the 8th international conference on learning analytics and knowledge*, Association for Computing Machinery (ACM), Mar. 2018, pp. 270–279. doi: 10.1145/3170358.3170410.

[2] C. Calle Müller, M. Kayyali, and M. Elzomor, "Board 139: Factors Affecting Enrollment, Retention, and Attrition of STEM Undergraduates at a Minority Serving Institution," in *2023 ASEE Annual Conference & Exposition*, 2023.

[3] N. Mani, "Critical Factors Affecting Enrollment, Performance, and Retention & Graduation Rates of Construction Management Undergraduate Students," in *Proceedings of the 2020 IEMS Conference* , 2020, pp. 81–87.

[4] A. Sithole, E. T. Chiyaka, P. McCarthy, D. M. Mupinga, B. K. Bucklein, and J. Kibirige, "Student Attraction, Persistence and Retention in STEM Programs: Successes and Continuing Challenges," *Higher Education Studies*, vol. 7, no. 1, p. 46, Jan. 2017, doi: 10.5539/hes.v7n1p46.

[5] C. Calle Müller, M. Kayyali, and M. Elzomor, "Factors Affecting On-Time Graduation of Engineering and Construction Management Undergraduates at a Minority Serving Institution," in *2023 ASEE Annual Conference & Exposition*, 2023.

[6] X. Wang, "Why Students Choose STEM Majors: Motivation, High School Learning, and Postsecondary Context of Support," *Am Educ Res J*, vol. 50, no. 5, pp. 1081–1121, Oct. 2013, doi: 10.3102/0002831213488622.

[7] D. A. Cook and A. R. Artino Jr, "Motivation to learn: an overview of contemporary theories," *Med Educ*, vol. 50, no. 10, pp. 997–1014, Oct. 2016, doi: 10.1111/medu.13074.

[8] A. Javaeed, A. Asghar, Z. Allawat, Q. Haider, K. J. Mustafa, and S. K. Ghauri, "Assessment of Academic Motivation Level of Undergraduate Medical Students of Azad Kashmir, Pakistan," *Cureus*, vol. 11, no. 3, Mar. 2019, doi: 10.7759/cureus.4296.

[9] A. J. Martin, "The Student Motivation Scale: A Tool for Measuring and Enhancing Motivation," *J Psychol Couns Sch*, vol. 11, pp. 1–20, 2001.

[10] A. Tayebi, J. Gomez, and C. Delgado, "Analysis on the Lack of Motivation and Dropout in Engineering Students in Spain," *IEEE Access*, vol. 9, pp. 66253–66265, 2021, doi: 10.1109/ACCESS.2021.3076751.

[11] R. J. Vallerand, M. R. Blais, N. M. Briere, and L. G. Pelletier, "Construction et validation de I'echelle de motivation en educa-tion (EME)," *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*, vol. 21, no. 3, p. 323, 1989.

[12] M. Bruinsma, “Motivation, cognitive processing and achievement in higher education,” *Learn Instr*, vol. 14, no. 6, pp. 549–568, Dec. 2004, doi: 10.1016/j.learninstruc.2004.09.001.
[13] B. Abar, C. C. Abar, M. Lippold, C. J. Powers, and A. E. Manning, “Associations between reasons to attend and late high school dropout,” *Learn Individ Differ*, vol. 22, no. 6, pp. 856–861, 2012, doi: 10.1016/j.lindif.2012.05.009.
[14] Z. Dörnyei, “Motivation in action: Towards a process-oriented conceptualisation of student motivation,” *British Journal of Educational Psychology*, vol. 70, no. 4, pp. 519–538, 2000, doi: 10.1348/000709900158281.
[15] B. Oláh, Á. Münnich, and K. Kósa, “Identifying academic motivation profiles and their association with mental health in medical school,” *Med Educ Online*, vol. 28, no. 1, 2023, doi: 10.1080/10872981.2023.2242597.
[16] E. L. Deci and R. M. Ryan, “The Empirical Exploration of Intrinsic Motivational Processes,” *Adv Exp Soc Psychol*, vol. 13, no. C, pp. 39–80, Jan. 1980, doi: 10.1016/S0065-2601(08)60130-6.
[17] R. M. Ryan and E. L. Deci, “Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions,” *Contemp Educ Psychol*, vol. 61, Apr. 2020, doi: 10.1016/j.cedpsych.2020.101860.
[18] N. Savage, R. Birch, and E. Noussi, “Motivation of engineering students in higher education,” *Engineering Education*, vol. 6, no. 2, pp. 39–46, 2011, doi: 10.11120/ened.2011.06020039.
[19] H. Afzal, I. Ali, M. Aslam Khan, and K. Hamid, “A study of university students’ motivation and its relationship with their academic performance,” *International Journal of Business and Management*, vol. 5, no. 4, pp. 80–88, 2010.
[20] J. M. Froiland, E. Oros, L. Smith, and T. Hirchert, “Intrinsic Motivation to Learn: The Nexus between Psychological Health and Academic Success,” *Contemporary School Psychology: Formerly" The California School Psychologist"*, vol. 16, pp. 91–100, 2012.
[21] M. Karaguven, “The Adaptation of Academic Motivation Scale to Turkish,” *Educational Sciences: Theory and Practice*, vol. 12, no. 4, pp. 2611–2618, 2012, [Online]. Available: www.edam.com.tr/estp
[22] B. K. S. Utvær and G. Haugan, “The Academic Motivation Scale: Dimensionality, Reliability, and Construct Validity Among Vocational Students,” *Nordic Journal of Vocational Education and Training*, pp. 17–45, Nov. 2016, doi: 10.3384/njvet.2242-458x.166217.
[23] R. J. Vallerand, L. G. Pelletier, M. R. Blais, N. M. Brière, C. Senecal, and E. F. Valliéres, “On the assessment of intrinsic, extrinsic, and amotivation in education: Evidence on the concurrent and construct validity of the Academic Motivation Scale,” *Educ Psychol Meas*, vol. 53, no. 1, pp. 159–172, 1993.
[24] Y. Xiong, “An exploration of Asian international students’ mental health: Comparisons to American students and other international students in the United States,” Ohio University, 2018.
[25] J. E. Bemel, C. Brower, A. Chischillie, and J. Shepherd, “The Impact of College Student Financial Health on Other Dimensions of Health,” *American Journal of Health Promotion*, vol. 30, no. 4, pp. 224–230, Mar. 2016, doi: 10.1177/0890117116639562.

[26] C. Calle Müller, M. Kayyali, and M. Elzomor, “Changing the Way We Educate to Prioritize Minority Students’ Mental Health and Enhance Their Well-Being,” in *2023 ASEE Annual Conference & Exposition*, 2023.
[27] D. Pusca, R. J. Bowers, and D. O. Northwood, “Hands-on experiences in engineering classes: The need, the implementation and the results,” *World Transactions on Engineering and Technology Education*, vol. 15, no. 1, pp. 12–18, 2017, [Online]. Available: https://www.researchgate.net/publication/316001791
[28] C. Grandzol and P. Wynn, “Retention, Motivation, and Enjoyment: An Exploratory Evaluation of the Effectiveness of Hands-On Learning,” *Journal of the Academy of Business Education*, vol. 12, 2011.
[29] M. Guerra and T. Shealy, “Teaching User-Centered Design for More Sustainable Infrastructure through Role-Play and Experiential Learning,” *Journal of Professional Issues in Engineering Education and Practice*, vol. 144, no. 4, 2018, doi: 10.1061/(ASCE)EI.1943-5541.0000385.
[30] C. Calle Müller, P. Pradhananga, and M. ElZomor, “Pathways to decarbonization, circular construction, and sustainability in the built environment,” *International Journal of Sustainability in Higher Education*, 2024, doi: 10.1108/IJSHE-09-2023-0400.
[31] P. Silva *et al.*, “Stairway to employment? Internships in higher education,” *High Educ (Dordr)*, vol. 72, no. 6, pp. 703–721, Dec. 2016, doi: 10.1007/s10734-015-9903-9.
[32] O. Rompelman and J. De Vries, “Practical training and internships in engineering education: Educational goals and assessment,” *European Journal of Engineering Education*, vol. 27, no. 2, pp. 173–180, Jun. 2002, doi: 10.1080/03043790210129621.
[33] H. Bae, M. Polmear, and D. R. Simmons, “Bridging the Gap between Industry Expectations and Academic Preparation: Civil Engineering Students’ Employability,” *Journal of Civil Engineering Education*, vol. 148, no. 3, Jul. 2022, doi: 10.1061/(asce)ei.2643-9115.0000062.
[34] R. K. Tener, M. T. Winstead, and E. J. Smaglik, “Experiential Learning from Internships in Construction Engineering,” in *Proceedings of the 2001 American Society for Engineering Education Annual Conference & Exposition*, 2001, pp. 6–486.
[35] E. Forcael, V. González, F. Orozco, A. Opazo, Á. Suazo, and P. Aránguiz, “Application of problem-based learning to teaching the critical path method,” *Journal of Professional Issues in Engineering Education and Practice*, vol. 141, no. 3, Jul. 2015, doi: 10.1061/(ASCE)EI.1943-5541.0000236.
[36] M. Elzomor, C. Mann, Kerice Doten-Snitker, K. Parrish, and M. Chester, “Leveraging Vertically Integrated Courses and Problem-Based Learning to Improve Students’ Performance and Skills,” *Journal of Professional Issues in Engineering Education and Practice*, vol. 144, no. 4, p. 04018009, 2018, doi: 10.1061/(ASCE)EI.1943.
[37] N. Capon and D. Kuhn, “What’s so good about problem-based learning?,” *Cogn Instr*, vol. 22, no. 1, pp. 61–79, 2004, doi: 10.1207/s1532690Xci2201_3.
[38] N. McWhirter and T. Shealy, “Case-based flipped classroom approach to teach sustainable infrastructure and decision-making,” *Int J Constr Educ Res*, vol. 16, no. 1, pp. 3–23, Jan. 2020, doi: 10.1080/15578771.2018.1487892.
[39] S. Akinci-Ceylan, K. S. Cetin, B. Ahn, A. Surovek, and B. Cetin, “Investigating Problem-Solving Processes of Students, Faculty, and Practicing Engineers in Civil Engineering,” *Journal of Civil Engineering Education*, vol. 148, no. 1, p. 04021014, 2021, doi: 10.1061/(ASCE)EI.2643.

[40] R. M. Marra, K. A. Rodgers, D. Shen, and B. Bogue, “Leaving engineering: A multi-year single institution study,” *Journal of Engineering Education*, vol. 101, no. 1. Wiley-Blackwell Publishing Ltd, pp. 6–27, 2012. doi: 10.1002/j.2168-9830.2012.tb00039.x.

[41] J. W. Colvin and M. Ashman, “Roles, risks, and benefits of peer mentoring relationships in higher education,” *Mentoring and Tutoring: Partnership in Learning*, vol. 18, no. 2, pp. 121–134, May 2010, doi: 10.1080/13611261003678879.

[42] B. K. Payne and M. Sumter, “College students’ perceptions about career fairs: what they like, what they gain, and what they want to see,” *Coll Stud J*, vol. 39, no. 2, pp. 269–276, 2005, [Online]. Available: https://eds.s.ebscohost.com/eds/delivery?sid=93271c9c-be08-40

[43] R. Misra and Michelle. McKean, “College students’ academic stress and its relation to their anxiety, time management, and leisure satisfaction,” *Am J Health Stud*, vol. 16, no. 1, pp. 41–51, 2000.

[44] D. Oman, S. L. Shapiro, C. E. Thoresen, T. G. Plante, and T. Flinders, “Meditation lowers stress and supports forgiveness among college students: A randomized controlled trial,” *Journal of American College Health*, vol. 56, no. 5, pp. 569–578, Mar. 2008, doi: 10.3200/JACH.56.5.569-578.

[45] O. Vorontsova-Wenger, P. Ghisletta, V. Ababkov, and K. Barisnikov, “Relationship Between Mindfulness, Psychopathological Symptoms, and Academic Performance in University Students,” *Psychological Reports*, vol. 124, no. 2. SAGE Publications Inc., pp. 459–478, Apr. 01, 2021. doi: 10.1177/0033294119899906.

[46] T. Elstad, P. Ulleberg, S. Klonteig, J. Hisdal, G. M. Dyrdal, and A. Bjorndal, “The effects of yoga on student mental health: a randomised controlled trial,” *Health Psychol Behav Med*, vol. 8, no. 1, pp. 573–585, Jan. 2020, doi: 10.1080/21642850.2020.1843466.

[47] J. J. F. Breedvelt *et al.*, “The effects of meditation, yoga, and mindfulness on depression, anxiety, and stress in tertiary education students: A meta-analysis,” *Frontiers in Psychiatry*, vol. 10, no. APR. Frontiers Media S.A., 2019. doi: 10.3389/fpsyt.2019.00193.