Board 120: A Study of the Bangladeshi Engineering Students' Perceptions to Succeed Academically

Mr. Md Sakib Ullah Sourav, Shandong University of Finance and Economics, China

Md Sakib Ullah Sourav is a master's student in the Department of Management Science and Engineering at the Shandong University of Finance and Economics, China. He has been engaged in diverse academic research domains since 2017 and is mostly interested in image processing, machine learning, and various aspects of engineering education. With a background in computational intelligence and engineering design, Sakib has developed a unique perspective on the need for a robust engineering education system in society.

Dr. Cristina Diordieva, Nanyang Technological University

Cristina Diordieva is currently the Project Coordinator for the World MOON Project. She was a Postdoctoral Research Fellow in the joint medical school (LKCMedicine) at Imperial College London in the UK and Nanyang Technological University in Singapore. She is a co-author of a report published by the World Health Organization (WHO) in Switzerland. Her research interests include educational technology, online learning, digital health, and language massive open online courses (L-MOOCs).

Ribhav Galhotra, Nanyang Technological University, Singapore

Ribhav Galhotra is a bachelor's student studying a double degree in Aerospace Engineering and Economics at Nanyang Technological University, Singapore. He is working on research projects relating to undergraduate engineering education under the School of Mechanical and Aerospace Engineering and the National Institute of Education as part of the Undergraduate Research Experience on Campus (URECA). With a keen interest in aerospace technologies and education, Ribhav has a strong inclination to enhance the education systems for the development of future engineers.

Shahid Md. Asif Iqbal, Premier University, Chattogram, Bangladesh

Shahid Md. Asif Iqbal is awarded PhD in Computer Science and Engineering (CSE) from Chittagong University of Engineering & Technology (CUET), Bangladesh. Before that, he completed his M.Sc. in CSE from Bangladesh University of Engineering and Technology (BUET), Bangladesh, and his B.Sc. in CSE from CUET. Currently, Dr. Asif is working as an Associate Professor in the Department of CSE of Premier University, Chattogram, Bangladesh. He is passionately involved in research, and his interests include TCP/IP, Content-Centric Networking, Software Defined Networking, Cloud Computing, Wireless Networks, IoT, and Network Security.

A Study of the Bangladeshi Engineering Students' Perceptions to Succeed Academically

Abstract
Engineering courses are inherently more complicated than any other academic discipline. Yet, engineering students struggle with numerous social and personal factors to maintain high academic performance throughout their degree. This study aims to over-surface Bangladeshi engineering students' perceptions of what influences them to graduate successfully. In many dimensions, such as infrastructure, quality of instruction, and access to cutting-edge research, engineering education in first-world nations will likely differ significantly from that in less developed countries. Therefore, this investigation's results aim to contribute significantly to the existing knowledge base. This study's outcome aims to understand better the factors that influence students' academic decisions, regardless of their engineering concentration and lay the initial work for future performance enhancements for the students, educators, and policymakers in the STEM areas.

Introduction

Bangladesh's engineering and technology sectors are expanding as the country's economy develops. Despite the country's relatively low level of economic growth, its engineering students have achieved remarkable academic performance, becoming some of the world's most qualified engineers. Researchers have demonstrated that self-efficacy, or the positive attitudes individuals hold about their skills to accomplish activities, influences how they operate in a particular domain, such as mental health and others [1, 2]. Increasingly, research findings indicate that psychological and motivational aspects might also be crucial determinants for determining the performance and perseverance of engineering students [3].

Many engineering students in Bangladesh are primarily motivated by their own aspirations. Increased self-efficacy is mainly congruent with the idea of greater ambition. When students believe in their ability to complete a particular activity or objective, they are driven to act in ways that increase the likelihood of success [1]. Often, students are motivated to succeed in engineering by their passion and attitude [11]. In addition, a solid foundation in disciplines such as mathematics, physics, and science inspires students to pursue higher education in engineering to pursue a career in various sophisticated and intriguing jobs [8]. Students are frequently motivated by the success of their seniors, and they want to achieve comparable levels of success by working hard and emulating their example.

Family history or strong family support is frequently regarded as another crucial factor in determining the motivations of engineering students in Bangladesh. The study by Veenstra et al. [16] specified nine pre-college characteristics crucial for students' academic achievement and retention in engineering, including the need for family support for engineering student success. Aside from that, it is usual for families to urge engineering students to continue higher education and accept the challenge of being an engineer [7]. This push is especially prevalent if the family has a background in engineering or a robust social standing [15]. In such instances, parents often support their children's academic endeavors, giving financial assistance and advice based on their own experiences. For many engineering students in Bangladesh, parental expectations play a

significant part in their academic motivation. Typically, parents have high expectations for their children's success, resulting in great pressure on the student. This pressure may be both beneficial and detrimental. It can motivate students to work hard and perform academically and also be a source of stress that can lead to burnout.

There is a strong culture of competitiveness among engineering students in Bangladesh and other parts of the world [9, 27]. This culture is fueled by a competitive labor market in which firms frequently hire the finest people regardless of background [12]. Therefore, engineering students frequently feel intense pressure to excel academically to distinguish themselves from their peers. This pressure is frequently internalized and may significantly motivate students to succeed academically. In addition, many engineering students in Bangladesh are driven by the possible financial benefits of a successful engineering career. With the proper credentials, engineers may access a growing number of well-paying engineering professions that provide financial security and stability [13]. This is especially true for students from low-income families, who may embrace engineering to escape poverty and improve their family's financial status.

As described, several underlying variables can impact engineering students in Bangladesh to achieve academic success. This study investigates the motivations of engineering students in Bangladesh, which correspond to factors such as core interest and belief to perform well in engineering, superior social status, high offered salary after graduation from the engineering domain, family expectations, job availability, and other factors. We postulate that the driving factors for engineering success among Bangladeshi students fall into three broad categories: personal ambitions, family background, and the impact of social pressures. This work preliminary attempts to answer the following research question: What are the Bangladeshi engineering students' perceptions that influence them to graduate successfully?

Literature Review

Based on a Microsoft survey [4], the top three criteria affecting students' decisions to major in engineering are enthusiasm for engineering, job availability, and good income. In published studies, the University of Louisville [5] and Arizona State University [6] mentioned the same three variables — employment availability, good salary, and interest. In the survey conducted by Arizona State University, students were asked why they were interested in engineering or applied science and given seven responses to rank in order of significance. About four-fifths or 79%, chose "Potentially decent compensation," 72% chose "Interesting work," and 63% chose "Many job opportunities" as their top three replies. In the study [5] conducted by the University of Louisville, freshmen from the class of 2011 were asked to respond to nine factors and rate the three most important ones when deciding on a professional path. "Interests me" was recognized as the top factor by the highest number of students (34%), as well as the top three factors by the highest percentage of students (64%). The second-highest response was "That I am convinced jobs will be accessible when I finish," which 21% of the students selected as the most important criterion and 56% as one of the top three. Over half of the students ranked "That pays well" among the top three responses. In the University of Louisville [5] study, students were asked, "Why did you decide to major in engineering?" In addition to good jobs and salaries, the comments included "Good at math and science" and support from parents and instructors. Above 90% of students selected "Good in math and science" from a list of options. The vast majority of

engineering students believe they are proficient in the subjects that are the core of their education. Therefore, it may be concluded that those who choose to major in engineering anticipate achieving success.

Research has yet to be conducted in Bangladesh, which is vital for improving the country's engineering education system and potential economic growth. Motivated by its urgency, this study seeks to identify and measure the level of fundamental elements that inspire Bangladeshi engineering students.

Method

To comprehend and interpret the perspectives of the students choosing engineering degrees, a qualitative inductive approach was inspired by [14] to collect information from the students [29]. Moreover, this qualitative study sought the perspectives of Bangladeshi first and second-year engineering students on the likely underlying elements that encourage them to excel academically. According to Patton [30], the unprocessed information gathered using qualitative methods, such as a direct quotation, might indicate participants' feelings, thoughts, experiences, and perspectives on a certain subject. Consequently, this study might provide a theoretical basis for addressing issues related to interest and retention within Bangladesh-based engineering education contexts.

Procedure

A semi-structured interview protocol was developed to examine the thought processes of engineering degree applicants. The interviews were led by questions that prompted students to provide particular experiences and opinions regarding their pursuit of an engineering degree. The questions are also intended to uncover the students' understanding of their own thought processes, which may assist in revealing aspects that contribute to thinking habits more closely aligned with the driving reasons. Each interview lasted around fifteen minutes and was recorded.

Before the interview, students were instructed on the interview protocol (e.g., questions on background and engineering) and confidentiality precautions. Completing a consent form vetted by the university's Institutional Review Board in Bangladesh permitted them to participate in the recorded interview. During the interview, the gender of the participants, their self-perception in their majors, and any noteworthy remarks made were recorded. To maintain participant anonymity, no personal information was collected (other than gender identification), and all participants were referred to anonymously in the publication. After conducting interviews, all audio recordings were transcribed into Word document format. Both in-person and online interviews adhere to the same protocol.

Participants

The students who participated in this study were selected intentionally. Therefore, the sample of the participants is purposeful. A participant chosen for purposeful sampling has the capacity to explain a certain theme, idea, or experience [22]. Consequently, the data was collected from a

total of eight students. Five undergraduate students were in their first year of study, and three were in their second year, majoring in computer science and electrical engineering at a private Bangladeshi University. All ethical considerations were maintained by the fifth author according to the institutional requirement. After removing the identities to maintain privacy and anonymity, the fifth author collected and shared data. He then shared it with the first and second authors for the analysis.

Data Analysis

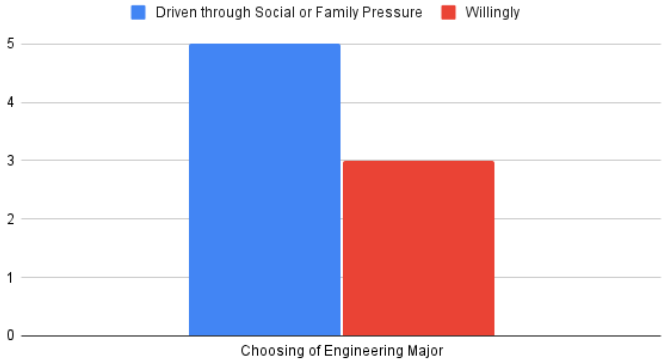
Following the semi-structured interviews' topic order, the data was analyzed. Two authors carried out the data coding. During the analysis, a consensus among researchers was attained. Thematic analysis was employed for analyzing the data based on what participants said, why they stated it, and what they intended to communicate about the subject matter. For example, what made them choose their engineering major, do they receive financial support from family, and so on? The data was reviewed and re-read after the interview transcription, and the categories were then identified and defined. Every sentence from the transcripts was used for content analysis, and the researchers concentrated on the cluster of sentences with identical and applicable meanings.

An inductive coding approach was used to analyze the participants' responses to open-ended questions and identify the developing themes from the semi-structured interviews [32]. This method was chosen to gain a deeper understanding of selecting engineering as a major from the participants' perspectives. In addition, this approach allows to analyze the data without preconceived notions and without seeking particular issues. A manual coding was used to analyze the data. The participants' quotations were coded into categories and later grouped into emerging themes. Throughout the analysis, four developing themes emerged.

Findings

Different factors motivate students to choose engineering as a major. The findings of this study indicate that more students choose to study engineering due to social or family pressure 63% rather than following their passion or willingness 37% (see Figure 1).

Figure 1. Factors influencing students' motivations to choose engineering majors



The distribution and examples of responses to the open-ended question are presented in Table 1. Table 1 below contains selected participant responses (with pseudonyms), the frequency of the codes (in percentages), and the themes that emerged. Four emergent themes of motivational factors are suggested by preliminary analysis: (1) confidence in a particular major, (2) parental support, (3) career opportunity, and (4) others. The first factor (1) refers to students' ability and backgrounds needed to feel confident in their major, factor (2) refers to the parent's view on pursuing an engineering major, factor (3) refers to the job and career prospects of engineering graduates, and factor (4) refers to a few other themes discussed later in the article.

Table 1. Summation of Frequencies Across Student Profiles

Theme	Frequency of code	Examples
Confident in a particular major	5/8 (62.5%)	*"Initially I did not felt confident because of the pressure that I face from the academic environment. The courses were intensely designed in such a way that it made me so stressful. Over time I got my confidence back and the interest was increasing towards my discipline."-Imran* *"As a computer science and engineering student, I think math and physics are the most vital abilities" - Masud*
Parental support	7/8 (87.5%)	*"My family inspires me to excel academically. My parents, elder sister and maternal uncles are supportive of me pursuing engineering academic programs in general."- Mahmud*
Career opportunity	8/8 (100%)	*"Nowadays, if anyone is skilled, no matter what background they have they can be successful. However, in general, engineering has been regarded as one of the most desired professions in my country. Engineering jobs usually offer higher salaries in my country." - Tabassum*
Others (E.g., familial connections to engineering)	6/8 (75%)	*"I have engineers in my extended family'- Faizul* *"My husband is an engineer."- Meem*

The results show that participants have diverse conceptions of engineering's motivating factors. We discussed the main themes of our findings below.

Solid Foundation in Mathematics and Science

While interviewing, most students (62.5%) expressed that a solid grasp of mathematics and science is needed to feel confident and perform well in their major in engineering. It corroborates the research findings in [8, 9, 10, 28], indicating that math-savvy students are more successful

and likely to enroll in engineering. Some students think being updated with the current state of information technology is also vital for engineering students' success. In contrast with Table 1, we can see from the students' responses that a significant percentage do not feel highly confident about their major due to a lack of self-assurance during their academic learning. However, unique solutions, such as problem-based learning strategies, may help address the learning gap for engineering students who feel less confident in mathematics and science [26]. The analysis of small group learning procedures presented in [16] suggests that more time spent working in groups is associated with more positive attitudes among general science, mathematics, engineering, and technology students. Even minimal group work can have positive effects on student achievement. Also, exposing students to engineering education at a younger age could help them understand the importance of engineering regardless of their background and become more confident in their technical knowledge and skills [23]

The positive attitude towards engineering among Bangladeshi parents

Most Bangladeshi parents favor pursuing engineering for their kids in Bangladesh. Seven out of eight students (87.5%) during the interview said their parents support them in pursuing their engineering. Engineering continues to be a respected profession in Bangladesh and an essential aspect of the country's growth and economy. Our analysis shows that parents encouraged both boys and girls to study engineering, similar to the trend in other nations where requests for additional support for women in STEM-related disciplines are equally prominent [15].

Engineering employment is growing, attracting more students

All eight students in the interview expressed that they consider their perceived higher career prospects as one of the most significant motivating factors while pursuing an engineering education. According to a recent Bureau of Labor Statistics report, the number of engineers is expanding faster than the average for all occupations [17]. This expansion draws more students to the engineering field, particularly those interested in a job with the potential to have a lasting influence on society. The typical salary for engineers in the United States is slightly over $87,000 per year [17]; engineering positions are likewise noted for their high compensation. This, together with the increasing need for engineers, makes engineering an attractive career choice for people seeking a satisfying profession. To feel motivated, Bangladeshi students evaluate the broader career opportunities in engineering that our study uncovered, which will support these numbers.

Apart from the above three, we get several other nebulous themes from the students’ responses. For instance, six out of eight students said they have engineers in their family. This might also be another motivating factor for them to feel motivated to pursue engineering. A lower rate of female enrollment in engineering majors is evident from the experience of most interviewing students. The enrollment rate of female students majoring in computer science is higher between the two majors of the interviewing students. All the interviewed students in this study are from private university backgrounds and have to pay a certain amount of tuition, which many mentioned is paid by their parents. As such, it can be assumed that the students represent

privileged classes. The opinions and feelings on the motivating factors towards engineering may differ among other student populations.

Discussion and Implications

From the above findings, it is evident that students have an interest to considerable portions towards pursuing their major, and parental support, along with a few other factors, influence on students' mindset to excel academically. Hence, these findings address the initial research question. The study's findings may be useful to help higher education institutions and policymakers in Bangladesh strengthen the activities required for the success of future engineering students. We anticipate that the opinions of Bangladeshi parents toward engineering will be mainly favorable, which will support the findings of studies in [19, 20]. To promote engineering, we may capitalize on students' positive attitudes by offering additional opportunities to develop their engineering self-efficacy [31,33] and how parents can assist their children in acquiring engineering procedures and skills. Moreover, engineering students in Bangladesh need a conducive learning atmosphere. They should have access to a library, laboratory, and other resources. This can contribute to an environment that is favorable to learning. The expanding economy of Bangladesh has afforded students the chance to obtain expertise in engineering [18], which has also served as a significant motivation for the students. Engineering students recognize that their education and experience may give them a competitive edge in the job market. As a result, they are encouraged to work diligently and achieve success. In Bangladesh, the combination of enhanced educational resources, a competitive job market, family and peer support, and a booming economy might all contribute significantly to engineering students' academic success. However, as Bangladesh is a less tech-resourced country, biomimicry-based methods suggested in a study [24] can be adopted in the future to understand Bangladeshi students' effective pursuit of engineering education in a better way.

Educational institutions in Bangladesh are generally unwilling to do this sort of study due to a lack of compliance standards synchronized with colleges in first-world nations and to preserve their institution's privacy, which limits comprehension. The authorities need to be swifter in taking measures from various perspectives to conduct surveys and update student experience via partnerships between government and foreign organizations. Several tactics and undertakings, such as those outlined in the study [21] on large-scale data gathering for engineering research, might be employed to achieve this objective. Having said that, authorities should pay additional attention while implementing any forthcoming policies related to engineering education as it is quite different from other education disciplines [25]. The implications of the current study might unquestionably aid engineering students in Bangladesh in breaking down barriers to academic achievement and achieving greater future success in their engineering careers.

Conclusion and Future Direction

Engineering students in Bangladesh are driven to achieve academic success by many motivations. These include their parents' expectations, the pressure from their classmates and society, the desire to achieve success, and the general availability of more resources and

assistance. This research aimed to determine how these elements affect engineering students in their first and second years of study in Bangladesh. It is reasonable to anticipate that if future Bangladeshi engineering students are provided with an appropriate grasp of these variables and the required assistance, they will be able to achieve academic success in their endeavors. The future endeavors related to this work should employ a quantitative method to experimentally validate the understanding acquired from the three characteristics discussed in the result section.

Reference

1. Self-efficacy: The exercise of Control. (1997). *Choice Reviews Online, 35*(03). https://doi.org/10.5860/choice.35-1826
2. Sourav, M. S., Zhang, X., & Wang, H. (2021). Social media as information support in reducing COVID – 19 depressions: Self-efficacy as mediator for behavioral modeling. 2021 11th International Conference on Intelligent Control and Information Processing (ICICIP). https://doi.org/10.1109/icicip53388.2021.9642194
3. Lent, R. W., Miller, M. J., Smith, P. E., Watford, B. A., Hui, K., & Lim, R. H. (2015). Social cognitive model of Adjustment to engineering majors: Longitudinal Test across gender and race/ethnicity. *Journal of Vocational Behavior, 86*, 77–85. https://doi.org/10.1016/j.jvb.2014.11.004
4. *Microsoft releases National Survey findings on how to inspire the next generation of doctors, scientists, software developers and Engineers*. Stories. (2022, March 15). https://news.microsoft.com/2011/09/07/microsoft-releases-national-survey-findings-on-how-to-inspire-the-next-generation-of-doctors-scientists-software-developers-and-engineers/
5. Honken, N. B., & Ralston, P. (2013). *Freshman engineering retention: A holistic look*. Journal of STEM Education: Innovations and Research. https://www.jstem.org/jstem/index.php/JSTEM/article/view/1750
6. *Understanding Freshman Engineering student retention through a survey*. (1997). https://peer.asee.org/understanding-freshman-engineering-student-retention-through-a-survey.pdf
7. San Miguel, A. M., & Kim, M. M. (2014). Successful Latina scientists and engineers. *Journal of Career Development, 42*(2), 133–148. https://doi.org/10.1177/0894845314542248
8. Pepin, B., Biehler, R. & Gueudet, G. Mathematics in Engineering Education: a Review of the Recent Literature with a View towards Innovative Practices. *Int. J. Res. Undergrad. Math. Ed.* 7, 163–188 (2021). https://doi.org/10.1007/s40753-021-00139-8
9. M.S.U Sourav, V.C.Hou, S.L. Morsten, C. Diordieva, J. Radloff, M. Park, and Ibrahim H. Yeter, (*In press*) "Exploring Engineering Education in Bangladesh, Hong Kong, Singapore, and Switzerland: An International Perspective", *2022 IEEE International Conference on Engineering, Technology & Education (TALE)*, Hong Kong, December 2022
10. Hutchison, M. A., Follman, D. K., Sumpter, M., & Bodner, G. M. (2006). Factors influencing the self-efficacy beliefs of first-year engineering students. *Journal of Engineering Education, 95*(1), 39–47. https://doi.org/10.1002/j.2168-9830.2006.tb00876.x
11. Besterfield-Sacre, M., Atman, C. J., & Shuman, L. J. (1997). Characteristics of freshman engineering students: Models for determining student attrition in engineering. *Journal of Engineering Education, 86*(2), 139-149. https://doi.org/10.1002/j.2168-9830.1997.tb00277.x

12. Brown, R., Brown, J., Reardon, K., & Merrill, C. (2011). Understanding STEM: current perceptions. *Technology and Engineering Teacher*, *70*(6), 5.
13. Olson, S., & Riordan, D. G. (2012, January 31). *Engage to excel: Producing one million additional college graduates with degrees in science, Technology, engineering, and mathematics. report to the president.* Executive Office of the President. https://eric.ed.gov/?id=ED541511
14. S. Venkatesh, E. W. Fong and I. H. Yeter, "Investigating Ethics in an Undergraduate Design Thinking Project: The Stanford EDIPT Framework Approach in Southeast Asia," 2022 IEEE Frontiers in Education Conference (FIE), Uppsala, Sweden, 2022, pp. 1-5, doi: 10.1109/FIE56618.2022.9962748.
15. Verdin, D., & Godwin, A. (2015, October). First in the family: A comparison of first-generation and non-first-generation engineering college students. In *2015 IEEE Frontiers in Education Conference (FIE)* (pp. 1-8). IEEE. doi: 10.1109/FIE.2015.7344359.
16. Springer, L., Stanne, M. E., & Donovan, S. S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of educational research*, *69*(1), 21-51. https://doi.org/10.3102/00346543069001021
17. U.S. Bureau of Labor Statistics. (2020). *2020 home*. U.S. Bureau of Labor Statistics. https://www.bls.gov/opub/mlr/2020/
18. Haque, M. S., & Sharif, S. (2021). The need for an effective environmental engineering education to meet the growing environmental pollution in Bangladesh. *Cleaner Engineering and Technology*, *4*, 100114. https://doi.org/10.1016/j.clet.2021.100114
19. Zulkifli, A. Z. B., Yeter, I., & Ali, F. (2022, August). Examining K-12 Singaporean parents' engineering awareness: An initial study of the knowledge, attitude, and behavior (KAB) framework (fundamental). In *2022 ASEE Annual Conference & Exposition*.
20. Ehsan, H., Rehmat, A. P., Osman, H., Ohland, C., Cardella, M. E., & Yeter, I. H. (2019, June). Examining the role of parents in promoting computational thinking in children: A case study on one homeschool family (Fundamental). In *2019 ASEE Annual Conference & Exposition*.
21. Yeter, I., Rynearson, A., Ehsan, H., Rehmat, A., Dasgupta, A., Fagundes, B., Menekse, M., & Cardella, M. (2019) Design and implementation of data collection in a large-scale, multi-year Pre-College Engineering Study: A retrospective. *2019 ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--32596
22. Robinson, R. S. (2014). Sampling in interview – Based qualitative research: A theoretical and practice guide. *Journal Qualitative Research in Psychology, 11*(1), 25– 41. https://doi.org//abs/10.1080/14780887.2013. 801543
23. Venkatesh, S., Yeter, I. H., & Fong, E. (2022). An initial investigation of funds of knowledge for first-generation and continuing-generation engineering students in Singapore. In *Proceeding of the American Society for Engineering Education (ASEE) Conference & Exposition*.
24. I. H. Yeter, V. S. Q. Tan, and H. Le Ferrand, (Mar. 2023) Conceptualization of Biomimicry in Engineering Context among Undergraduate and High School Students: An International Interdisciplinary Exploration, *Biomimetics*, vol. 8, no. 1, p. 125, , doi: 10.3390/biomimetics8010125.
25. M. Van den Bogaard, I. H. Yeter and J. Strobel, "A literature overview of differences between engineering education and other disciplinary education," 2021 IEEE Frontiers in

Education Conference (FIE), Lincoln, NE, USA, 2021, pp. 1-4, doi: 10.1109/FIE49875.2021.9637143.
26. Burley, H., & Williams, C. M., & Youngblood, T. D., & Yeter, I. H. (2016, June), *Understanding "Failure" is an Option* Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.27095
27. Yeter, I. H., & Burley, H., & Youngblood, T. D., & Williams, C. M. (2016, June), *Developing a Questionnaire and Evaluation Methods for a High School Rocket Program* Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26730
28. Yeter, I. H., & Radloff, J., & Diordieva, C. (2022, August), *Exploring the Presence of Engineering Indices in the Singaporean High School Physics Standards: A Content Analysis (work-in-progress)* Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. https://peer.asee.org/41737
29. Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches*. Sage.
30. Patton, M. Q. (1983). *Qualitative evaluation methods*. Sage.
31. Hammack, R., & Ivey, T. (2017). Examining elementary teachers' engineering self-efficacy and engineering teacher efficacy. *School Science and Mathematics, 117*(1-2), 52–62. https://doi.org/10.1111/ssm.12205
32. Maxwell, J. (2009). Designing a qualitative study. *The SAGE Handbook of Applied Social Research Methods*, 214–253. https://doi.org/10.4135/9781483348858.n7
33. Hammack, R., & Yeter, I. H. (2022, August). Exploring pre-service elementary teachers' engineering teaching efficacy beliefs: A confirmatory analysis study (fundamental). In *2022 ASEE Annual Conference & Exposition*. https://peer.asee.org/41231