

Rural School Students' Attitudes and Perceptions toward the Engineering Education and the Engineering Profession

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Abstract—As the growth of science and technology accelerates, the prospect of engineering as a field of study and profession gains importance. Many school students prefer to study engineering in the future and work as engineers. Examining their views on engineering will help correct frivolous attitudes and proactively revamp engineering education. However, only a few studies have been conducted on secondary school students' attitudes and perceptions toward engineering, especially from the schools located on rural outskirts. Against this backdrop, this study critically examines rural secondary school students' attitudes and perceptions of engineering education and the engineering profession. The students were part of the Rural Student Technical Enhancement Program (R-STEP), conducted by the IEEE Education Society. The program was designed as a free-of-cost advanced technical training and skilling session for rural higher secondary students in Kerala, a southern state in India. The data collection for the study was performed by administering a questionnaire containing ten questions, among which five were concerning engineering education, and the other five were on the engineering profession. The questionnaire was prepared in the regional language (Malayalam), considering the respondents' age group and background. A total of 225 responses were collected from students from various districts of Kerala. The questionnaire responses were then critically analyzed to interpret students' opinions on engineering education and profession. The research findings show that nearly 60% of rural higher secondary school students sincerely aspire to become engineers. It is also observed that about 50% of students acknowledge that engineers should exhibit problem-solving skills. Another noticeable finding is that about 80% of students accept the significance of practical laboratory-oriented learning in engineering education. On the other hand, more than 30% of students are confused about

the significance of mathematics in engineering. Another 30% of students even observed that mathematical aptitude is not obligatory for engineering education. More insights from other questions identified students' attitudes and perceptions toward the engineering profession. The study concludes with a few curative suggestions and recommendations to enhance rural school students' awareness of engineering education and profession.

Index Terms—Engineering Education, Engineering Profession, Rural Schools, Students' Perceptions

I. INTRODUCTION

Progressions in the Science, Technology, Engineering, and Mathematics (STEM) fields are crucial in driving any country's long-term development and economic growth. STEM education, in this regard, is getting more attention nowadays. Many countries are found to revise their education policy by providing prominence to engineering and technology education [1] [2]. Among the other STEM domains, engineering has been proven to be unique in upskilling students by making them capable of applying mathematical and scientific knowledge [3]. Further, the significance and demand for careers related to engineering and technology are also increasing [4]. Hence, there is a visible growth in recognition for engineering education and the engineering profession across the globe.

On the other hand, it is not easy to integrate topics from engineering and technology into the teaching curriculum and classroom learning in schools [36]. The multifarious and complex nature of engineering can be a reason for its

inadequate inclusion in school teaching. Consequently, not many school students are exposed to engineering during their school education [6]. Even secondary school students have limited awareness of engineering education and the engineering profession [7]. This issue is more significant in schools situated in rural village areas than in urban schools. Even opportunities to be acquainted with engineering and technology are relatively few for rural school students. All this may contribute to their frivolous perceptions of engineering. Further, the misconceptions regarding the engineering field may even cause productive and enterprising school students not to choose the path of an engineering career in the future [8].

Against this backdrop, this paper critically analyses rural school students' attitudes and perceptions towards engineering education and profession. In particular, the research study analyzed the perceptions of rural school students who participated in a preuniversity STEM training program by the IEEE Education Society Kerala Chapter. The program was titled 'Rural Student Technology Enhancement Program' (R-STEP). R-STEP was an innovative advanced technical training session for higher secondary students living in the rural outskirts of Kerala, India. Its specific objective was to provide the underprivileged student sections with the necessary training to acquaint them with engineering and technology. The IEEE Education Society Kerala Chapter provided free hands-on training sessions in computer programming, Arduino, Internet of Things (IoT), and Web Development through R-STEP. With the help of this initiative, the participants were able to achieve early technical expertise in several in-demand skills of the industry. R-STEP helped rural school students to enhance their technical skills and make up worthwhile projects with the support and help of expert mentors from IEEE.

Our research study was conducted with the R-STEP participants to analyze their perceptions regarding engineering education and the engineering profession. The data collected through the study was used to form a mixed method interpretation of the students' attitudes to develop strategies for rectifying their frivolous perceptions. The following section reviews previous works on school students' attitudes and perceptions of engineering education and profession.

II. LITERATURE REVIEW

Understanding students' perceptions of engineering is an essential step in formulating the syllabus for an engineering-based curriculum or assessing pupils' career aspirations. Even though the intentions of various researches done in this field differ from the concerned objective of this study, the methodologies used to assess these perceptions and the findings have been used as a reference and to discuss the limitations mentioned in the study.

An international quantitative study regarding the preconceptions about engineering among students of grades 9 - 12 was conducted by Koycu and de Vries [9]. They used a combination of two methods for the study, a concept map, and a Likert- questionnaire. They said that the upper secondary

school pupils were familiar with the different dimensions of engineering like research, design and development, and social and managerial dimensions. The upper secondary students also had a better understanding of engineering than students of lesser age groups. They also identify the presence of a regional difference in the paper, which is not analyzed thereon.

In the research conducted by Chan et al., a pretested questionnaire was used to analyze the influence of students' perception of engineers on their career aspirations in engineering [10]. The survey determined this based on four parameters - gender, grade level, family engineering background, and engineering experiences. The research found that the students assessed the engineering profession in four different but still connected dimensions: innovation and entrepreneurship competencies, Science, Technology, Engineering and Mathematics (STEM) related aptitudes, hands-on work status, and career prestige. However, the base data for these findings were collected through self-report measures and could be influenced by many factors. Also, the study does not address the geographical location or the level of urbanization as an influencing factor for the perception of students about engineering. The research by Lyons et al. also uses a 5-point Likert scale with statements to analyze middle school students' attitudes towards engineers [11]. All the statements were related to engineering as a profession. The survey found that the students view engineering as a boring job and engineer as someone who is good at math and who makes people's lives easier. It revealed the misconceptions or lack of conceptions regarding engineering among the students.

According to Reyer, the three main factors that attract or repel students to the engineering field are Confidence Levels, Support Networks, and Perceptions [12]. The survey instrument contained 60 questions related to the former three factors. The study discovered the limited knowledge of students regarding engineering as a profession. It also talks about the willingness of the students to learn more about engineering. Hirsch et al., in their studies, conducted a survey where students' awareness of Engineering Careers was evaluated using multiple-part open-ended, and closed-ended format questions [13]. A board of expert judges investigated the survey and specified several potential subscales within the engineering section. Results indicate that even students who have favorable attitudes towards engineering and are considering choosing to engineer have limited knowledge of engineering careers and what engineers do. Bevins et al.'s research aimed to point out secondary school students' views of engineering and an adequate explanation for the fewer participation of young people in engineering-related subjects [14]. Here also, a questionnaire was used for collecting data. They believe that there needs to be input from career professionals to the students to improve their currently not rich information regarding engineering theory and practice.

English. et al. conducted a study about middle school students' perceptions of engineering [15]. They transcribed data from verbal exchanges between students and teachers and analyzed it. They found that the knowledge of the students

about engineering seemed to be focused on large constructions, and the students could not identify the design aspect of engineering. They also observed that the students have less information on the various streams of engineering as well. Bevins et al. extended their previous research conducted in 2004 and 2010 [16] to include focus group interviews. They noted that although people's interest in science and engineering has increased, the knowledge of students regarding science and engineering has not improved significantly. In another study by Karatas et al. [17], the authors focus on the views of sixth-grade students about engineering and images of engineering. They conducted a series of interviews with the students and asked questions about engineers and the engineering process in a semi-structured format. This study also confirmed the results of the previous work done in this field and concludes that middle schoolers perceive engineering as a profession involving construction work and are less aware of its design or testing aspects.

Utley et al. studied the perceptions of engineering among a different age group of elementary students after participating in an instruction and curriculum program [18]. It was noticed that the program could enlighten the participants about the basic ideas concerning engineering and technology. Still, they couldn't identify the actual work of an engineer or how one uses math in various engineering dimensions. Ergün and Balcin researched fifth and sixth-grade secondary school students' attitudes towards engineering [19]. The study was carried out through a questionnaire and a Draw An Engineer Test (DAET), which revealed students' attitudes toward engineers. The students distinguished engineers as construction workers, designers, managers, and repairers, reflecting their lack of a clear idea of engineering. A gender stereotype was also noted during the survey.

Most of the literature in the concerned domain concludes that school students' information regarding engineering is limited and often incorrect. Also, most studies assess students' attitudes by including factors such as gender and family background. In our literature review, we found that the work that analyzes the perception of engineering among rural students was rare, which illustrates the significance of this paper.

III. SIGNIFICANCE OF THE STUDY AND RESEARCH QUESTIONS

As elaborated in the previous section, the demand for engineering, both as an educational stream and as a profession, has been experiencing a rapid increase over the years. However, there has not been a clear understanding of the student's perceptions regarding engineering education and the engineering profession. Though there are numerous studies concerning the impact of engineering education and profession, there exist no studies concerning rural students' attitudes towards them. Hence, this study we thought it was necessary to understand this research study to fill the void. In every way possible, this study has significantly portrayed a generalized sample of students' perceptions of engineering. It explores the factors contributing to students' specific attitudes towards engineering

education and the engineering profession and supports them with data from the real world.

The following questions were part of our research work on rural school students' perceptions. These questions helped us identify their attitudes towards engineering education and the engineering profession.

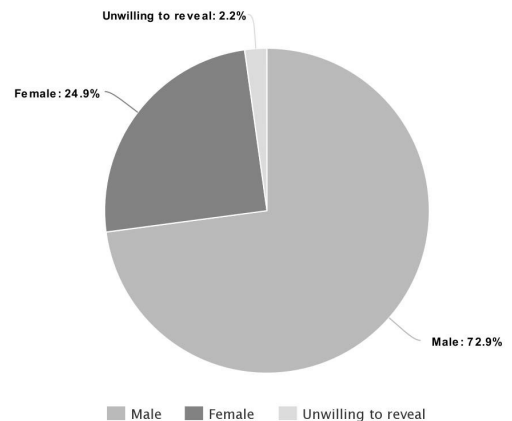
- 1) Do rural students want to be future engineers?
- 2) What are the perceptions of higher secondary students in the rural areas regarding engineering education?
- 3) What is the attitude of rural higher secondary students towards the engineering profession?

IV. METHOD

The methodology used for the study was that of a mixed analysis based on a questionnaire. The study was conducted via the virtual platform using Google Forms as the primary tool. Through this methodology, we collected data regarding students' perceptions anonymously without storing the participants' personal information. During October and November 2021, we collected 225 responses through the questionnaire. We conducted further analysis of the data and drew conclusions based on our results.

A. Participants and Tools

A questionnaire was prepared and administered to examine the attitudes and perceptions of rural school students toward engineering education and the engineering profession. A pilot study was conducted with this questionnaire to determine the feasibility of our research design. After making necessary modifications, based on the pilot study, we shared the questionnaire among rural higher secondary school students. These students were part of the R-STEP initiative, which the IEEE Education Society Kerala Chapter organized. We collected a total of 225 responses to the questionnaire from the students spread across various districts of Kerala. During the data collection, we collected no personal information from the participants except their gender. In place of gender, 72.9% of participants responded as male, 24.9% responded as female, and the remaining 2.2% of participants were unwilling to reveal this information.



The survey was conducted in an online mode using Google Forms. Considering the respondents' age group and background, we translated the questions into the regional language (Malayalam) to make it easier for the children to comprehend. The questionnaire also adopted an emoji meter as a projective technique for collecting the responses to each question. The emoji meter was designed to measure the responses to each question in 5 categories, namely Strongly Agree, Agree, Not Sure, Disagree, and Strongly Disagree. The specific reason for incorporating the emoji meter as our projective technique was that the participants found it very simple to understand the Likert scale through this representation.

The questionnaire was structured to consist of a total of ten questions. The first five questions were related to engineering education, and the remaining five concerned the engineering profession. The responses to these questions were collected and were used for further data analysis, interpretation, and explanations of the attitudes and perceptions of school students about engineering education and the engineering profession. The questions that were included are as follows.

- 1) Do you believe that only students with higher marks in high school can opt for engineering?
- 2) Do you agree that engineers make others' life simple?
- 3) Do you believe that engineering education offers opportunities?
- 4) Are you of the idea that only students with high mathematical skills can pursue an engineering course?
- 5) Do you agree that engineering is a profession where people interact socially with each other?
- 6) Do you believe that engineering education primarily focuses on practical learning?
- 7) Do you believe that engineers are people with high knowledge of science?
- 8) Do you agree that only students with high drawing skills can prosper in engineering studies?
- 9) Do you believe that engineers are people with high problem-solving skills?
- 10) Do you want to be an engineer in the future?

B. Limitations of the study

Though the study efficiently addresses our objectives, there still exist some limitations. Due to certain constraints, we could not add any questions regarding the perception of the students' families about engineering education and the engineering profession. Including such questions would have given us a broader view of analyzing the impact of a family's attitude on a child's education. Additionally, we did not consider gender-oriented questions regarding the subject in the questionnaire. Such questions would have helped us understand in greater depth the gender gap in engineering education and the engineering profession. Since our objective was to precisely understand the perception and attitude of rural school students towards engineering education and the engineering profession, we excluded these issues for future research. Also, as mentioned, this study was conducted as part of the R-STEP initiative of IEEE Education Society Kerala

Chapter. Hence, most of our participants were students who were already interested in technical domains. This selection limited our understanding of the perceptions and attitudes of rural students as a whole. Another study with a broader scope needs to be conducted to include the perceptions of the larger student populace.

V. FINDINGS AND DISCUSSIONS

Table I presents details about the central question in the questionnaire, which was whether students want to be an engineer in the future. The results show that a total of 93.7% of the respondents were willing to pursue a career in engineering. In comparison, the remaining 6.6% of the respondents were not open to this idea. In addition to that, about 14.2% of the respondents were unsure about what to choose. This data shows that only one-fifth of the total participants were unwilling to pursue engineering. A similar kind of result can be found in a study by Satya Sundar Sethy et al., where more than half of the attendees were willing to take engineering as their future career [20]. In the case of the study conducted by Satya Sundar Sethy, the participant's interest in taking up the engineering profession was influenced by their beliefs associated with the curriculum and the profession. Similarly, in this study, we noted that most of the participant's interest in taking up engineering as a career was deeply influenced by their perceptions of engineering.

The number of students unwilling to take up engineering as a career seems statistically insignificant. However, it was necessary to address why some participants decided not to take up the engineering profession as their career. A significant fact that might have contributed to this result is that the attendees of this questionnaire were students interested in technical domains. However, it was also necessary to find all the other possible reasons. The subsequent questions from the questionnaire were written to explore each of these.

Table II presents details about the student's perceptions regarding engineering education. We explicitly framed five questions in the questionnaire to address this research question. From the data obtained, it is clear that a total of 32.9% of the respondents were of the idea that only students with higher marks in high school can opt for engineering. Similarly, the table shows that the same percentage of respondents also believed that only students with excellent mathematical skills could pursue an engineering course. Likewise, a total of 12.5% also conveyed that they thought that only students with good drawing skills could do well in engineering studies. These students' perceptions clearly represent their thoughts regarding engineering education. The primary reason for such a response might be the influence of the social environment where these students belong. The common trend of associating engineering education with the characteristics mentioned above can be seen today, especially in visual communication. These trends might have shaped the students' perception regarding engineering education in the above manner.

In addition, these perceptions of the students can be seen as the primary reason for their disagreement in pursuing

TABLE I
DO STUDENTS WANT TO BE FUTURE ENGINEERS?

No	Question	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
10	Do you want to be an engineer in the future?	58.2%	20.9%	14.2%	5.3%	1.3%

engineering. The misconception that only people with the so-called characteristics can pursue engineering education might have forced a section of the students to fall to the conclusion of believing that engineering is not suitable for them. Hence from table II, we can justify the students' opinions in table I. Even though a fraction of students believed not to choose engineering as a career, a large section of the respondents was against that opinion. A total of 79.6% of the students thought that engineering education offers placement opportunities even before the course completion. Additionally, a total of 81.7% of students were of the idea that engineering education primarily focuses on practical learning. From this data, we can conclude that a high proportion of our participants are aware of the fundamental nature of engineering education. This set of data, depicting a positive attitude towards the course, clearly justifies the high ratio of students willing to take up engineering.

Table III presents details about the student's attitude towards the engineering profession. From the data obtained, it was inferred that a total of 70.2% of students believed that engineers are people with high knowledge of science. Additionally, a total of 72% of the respondents were of the idea that engineers are people with high problem-solving skills. These results are quite similar to the results obtained in the study by Muhammed Doğukan Balçın and Aysegul Ergun in 2018 [19]. There is a significant possibility that these attitudes of students influenced their decisions in Table I. These pre-built perceptions might have impacted their decision to pursue engineering.

In addition to the responses mentioned above, a total of 77.4% of students believed that engineers make others' lives simple, and a total of 62.7% of students believe that engineering is a profession where people interact socially with each other. Similar responses regarding the collaborative working nature of engineers can be found in the study conducted by N P Subheesh, S S Sathy in 2020 [36]. This data set can also be considered the driving force behind the students' willingness to pursue engineering.

To remind the reader, this study was conducted among school students in the rural outskirts of Kerala. After critically analyzing the collected data, we can conclude that various factors have influenced rural students' perceptions. Most students have little or no meaningful exposure to engineering practices throughout high school. Hence, their decisions for higher studies were found to be influenced by several factors. Through this study, we were able to address these factors and realize how they have impacted the attitude of such school students from rural backgrounds. We provided descriptive statistics associated with these findings.

VI. SUGGESTIONS AND RECOMMENDATIONS

As it is clear from the study, a fraction of students with certain misconceptions regarding engineering education and the engineering profession exist. The possibility for their false perceptions to influence the decisions of the coming generations cannot be neglected easily. With that realization, we have framed a set of suggestions and recommendations to address this situation. They are as follows.

- It would be better to initiate plans to orient and guide students, especially higher secondary students, regarding engineering education and the engineering profession. Such a mentorship will help the coming generations decide if engineering is the right path for them.
- Introducing various initiatives of IEEE to preuniversity students can also significantly resolve this issue to a greater extent. As a globally recognized organization with many experts and professionals in engineering, IEEE initiatives can enhance school students' awareness of engineering both as an educational stream and as a professional field.
- Through the R-STEP initiative, it has been realized how interactions with engineering students have helped them get in line with the engineering concepts. This is a clear sign of how students who are currently pursuing engineering can influence the school students. Therefore bringing up more initiatives involving engineering students as mentors may yield great results.

VII. CONCLUSION AND FUTURE SCOPE

This research study found that most rural school students preferred engineering as their career choice in Kerala, India. However, many of them were rooted around various misconceptions and frivolous perceptions regarding engineering education and the engineering profession. Furthermore, it was discovered that students in some places were unaware of the current state of engineering. For instance, when enquired about the requirements for getting admission in engineering, many students were not sure whether students without high marks in high school could opt for engineering or not. Such uncertainty depicts that students are not well aware of the engineering field, both as an educational stream and as a profession.

Since these perceptions cannot be neglected, it was necessary to make the students aware of engineering education and the engineering profession. Through further studies on this topic, critical initiatives can be brought into action to eradicate all these misconceptions from the minds of these students. Through them, we will be able to provide a clear understanding for coming generations regarding what engineering is about and what it is not about.

TABLE II
STUDENTS' PERCEPTIONS REGARDING THE ENGINEERING EDUCATION

No	Question	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1	Do you believe that only students with higher marks in high school can opt for engineering?	7.6%	25.3%	33.8%	26.2%	7.1%
3	Do you believe that engineering education offers placement opportunities even before the completion of the course?	32.9%	46.7%	14.2%	5.8%	0.4%
4	Are you of the idea that only students with high mathematical skills can pursue an engineering course?	6.2%	26.7%	32%	32.4%	2.7%
6	Do you believe that engineering education primarily focuses on practical learning?	32.4%	49.3%	14.7%	3.6%	0%
8	Do you agree that only students with high drawing skills can prosper in engineering studies?	0.9%	11.6%	31.1%	45.8%	10.7%

TABLE III
STUDENTS' ATTITUDES TOWARDS THE ENGINEERING PROFESSION

No	Question	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2	Do you agree that engineers make others' life simple?	35.6%	41.8%	16.9%	5.3%	0.4%
5	Do you agree that engineering is a profession where people interact socially with each other?	16%	46.7%	24.4%	12.4%	0.4%
7	Do you believe that engineers are people with high knowledge of science?	24.4%	45.8%	24%	4%	1.8%
9	Do you believe that engineers are people with high problem-solving skills?	24.9%	47.1%	23.1%	4%	0.9%

Though we tried to gain the perspective of rural students through this study, we still haven't received a more comprehensive picture of this matter. For this, an upgraded study incorporating all the rural students within the state can be conducted. This is one of the significant future scope of this study we aim to achieve. Apart from that, descriptive research on the perceptions of rural students on a pan-India basis has a lot of potentials. Such a study will help us to understand more about any peculiarities that may exist in the perceptions and attitudes of rural students regarding engineering education and the engineering profession.

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