Exploring Holistic Factors Shaping Undergraduate Engineering Student Development

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Abstract— Promoting the holistic development of engineering students has become crucial in light of the knowledge economy's fast changing landscape and changing market dynamics. In order to create an ecosystem that supports students' performance in a variety of areas, educational institutions are essential. Numerous studies highlight different strategies for improving research skills, extracurricular involvement, and academic performance. However, variables like gender, resource availability, geographic location, and family background are all deeply entwined with the complexities of student development.

The goal of this research paper is to provide a comprehensive framework for determining the various aspects affecting the development of undergraduate engineering students. Learning styles, reading comprehension, writing abilities, communication skills, leadership qualities, and research aptitude are all essential components of this framework. The main goal is to provide a thorough understanding of the complex interactions between these factors that influence students' overall development. An empirical study of 200 students from Rajarambapu Institute of Technology's Computer Science and Information Technology department is presented in this paper. The study makes use of student input gathered from carefully crafted surveys. These surveys are purposefully designed to identify barriers to students' growth.

A variety of factors are revealed by the analysis, each of which has a unique effect on students' development. Adoption of a variety of learning styles, skillful technology integration, enthusiasm for blended Massive Open Online Courses (MOOCs), independent self-learning techniques, basic programming abilities, and critical soft skills are all considered positive attributes. The study, on the other hand, highlights drawbacks such as a lack of enthusiasm for research and entrepreneurship development, deficiencies in programming logic construction, a lack of confidence when speaking in front of an audience, a lack of leadership skills, fear of being judged, a lack of innovative ideas, and a reluctance to take risks.

Keywords—Student development, holistic approach, outcome-based education

I. INTRODUCTION

According to National Education Policy 2020 published by Ministry of Human Resource Development, Government of India higher education is very important for promoting individual and society. Good higher education leads to sustainable economic development. The purpose of higher education is help students for personal accomplishment, constructive public engagement and productive contribution to the society. The purpose is to prepare students for meaningful lives and enable economic independence https://www.education.gov.in/sites/mhrd. Engineering institutions must ensure overall students' development. It needs to support students for good academic performance, placement in good companies, higher education, or initiating their own business.

To achieve the goals of National Educational Policy 2020, undergraduate engineering students need to think beyond examinations results. In literature many researchers investigated the factors affecting the students' performance. The different factors investigated in literature are as below,

- Age, gender, annual income, parents' occupation, parents' education, are included (Costa et al.,2017; Mahboob et. al., 2016).
- Academic data such as subject marks, previous examination marks are included in (Christian & Ayub, 2014; Guruler et al., 2010; Huang & Fang, 2013; Mahboob et. al., 2016; Sathe & Adamuthe, 2021)
- Previous semester marks and participation in activities are included in (Marbouti et al., 2016; Natek & Zwilling, 2014)

Student's previous school background, family background, availability of the different resources, gender etc. are considered in many investigations. There is a need to identify the factors affecting the student's development. This paper identifies the factors affecting the development of students through survey conducted for the students of the Computer Science and Information Technology Department. Various factors other than their academic performance like involvement in research, technical and soft skills, attitude towards learning, etc. were taken into consideration. The objectives of this study are mentioned below.

- Identify the factors affecting the students' performance in written examination i.e., academic performance.

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- Identify the factors affecting soft skills.
- Identify the factors affecting the research and development culture and entrepreneurship interest in the department.

Related work is described in section II. Section III presents proposed methodology. Section IV is about case study and discussion. Section V is conclusion.

II. RELATED WORK

In literature, many authors reported different ways to improve the students' development in academics, co-curricular activities, entrepreneurship and research. Students' development is strongly affected by family background, geographical location, availability of resources, gender etc. The different researchers tried to identify the factors affecting the student performance considering the particular aspect. For the students' overall development there is a need to do elaborative study from the student point of view focusing on the academic performance, soft skills, student's learning styles, student attitude, and practices followed while learning and their involvement in research and product development.

Martha (2009) statistically proven that academic performance as a dependent variable is related to the dependent variables, which are admissions points, parents' social-economic status, and student's former school. Laguador (2013) determined that to increase the level of student's academic performance arranging seminars on enhancing study habits was a must. This was concluded through the analysis of the level of the factors that affect the study habits and practices of engineering students at home and in school. The factors affecting the performance of engineering students in the assessment examination of the Mathematics course was determined by Camello (2014). Author considering the results of the OBE assessment examination grouped according to their profile variable like gender, high school attended, family income, mother's educational attainment, father's educational attainment, and distance of the school from the student's residence for analysis.

The role of entrepreneurship education was one of the critical factors to foster an entrepreneurial attitude (Rasli et al., 2013). Influencing factors on entrepreneurial intention were gender and work experience. Analysis done based on a set of questionnaires anchored on five-point scales is designed to measure the attributes of social content, an image of entrepreneurship, general attitudes, conviction, and intention. Kazeem and Asimiran (2016) observed that family factors, personality traits, and entrepreneurship education were essential factors for an entrepreneurial career.

Finch et al. (2013) studied the factors that influence the employability of university graduates and categorized them under soft skills, problem-solving skills, job-specific functional skills, pre-graduate experience and academic reputation. The findings suggested that learning outcomes linked to soft-skills development should take priority in the development of academic programs.

III. METHODS

Many times, student development is measured only in terms of performance in examinations. Biswal et al. (2025) created an assessment method to gauge the program and course outcomes of engineering graduates under outcome-based education. Condensed results and comparisons for ongoing quality improvement were made possible by the analysis of student exam scores. It also implied that indirect instruments, such as employer, graduate, and alumni surveys, might improve outcome assessment. To understand the various factors other than examination performance, surveys were conducted. The study focuses exclusively on students from the Computer Science and Information Technology department. No specific sampling method was applied since the entire population of the department was considered. The investigation is focused on gathering data from all 200 students within the Computer Science and Information Technology department, with a demographic split of about 60% female and 40% male students. Factors such as background distribution, educational background of parents, income status highlight the diverse socio-economic background of the students. Approximately 80% of the students are from rural backgrounds, while the remaining 20% reside in urban areas. Concerning the educational background of students' families, about 65% of parents have completed undergraduate studies, while the remainder have educational attainment below this level. Regarding income, the majority of parents fall below the required income threshold, leading many students to benefit from various scholarship opportunities.

The surveys were taken considering the factors such as descriptive examination performance, programming skills, professional skills, research aptitude, interest in entrepreneurship, self-learning ability, and learning styles of students. The questionnaires utilized for surveys were based on either the Likert scales or descriptive response options, and are mentioned in the following section. Responses were collected online from students.

The proposed method covers six dimensions of students' development shown in Fig. 1. The dimensions, purpose and plan survey details are presented below.
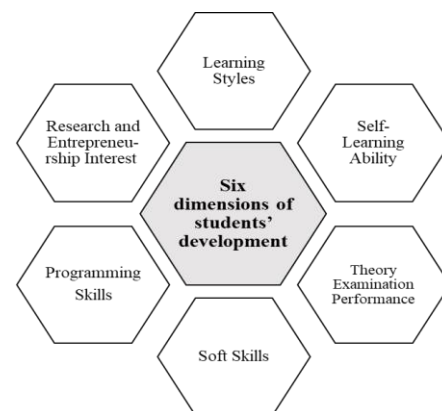

Fig. 1. Proposed Method

A. Learning Style

Learning styles refer to the various ways that students take

in and utilize the information based on their individual strengths and processing methods. Felder and Spurlin (2005) provided the applications, reliability and validity of the index of learning style. Richard Felder's learning style questionnaire, available at https://www.webtools.ncsu.edu/learningstyles/, was utilized to gain insights into students' preferred modes of learning. Learning styles encompass cognitive and psychological patterns that influence how individuals grasp, retain, and apply knowledge. The four dimensions, Active-Reflective, Sensing-Intuitive, Visual-Verbal, and Sequential-Global, represent contrasting cognitive preferences that impact information processing. Active learners engage in hands-on experiences, while reflective learners contemplate concepts. Sensing learners focus on concrete facts, whereas intuitive learners gravitate toward abstract concepts. Visual learners comprehend through visual aids, while verbal learners prefer textual explanations. Sequential learners follow ordered steps, while global learners perceive the big picture. Analyzing these dimensions aids educators in tailoring instructional strategies to cater to diverse learning preferences, fostering a more effective learning environment.

B. Self-Learning Ability

Self-directed learning, a crucial skill in modern education, involves students independently seeking and mastering knowledge. Prafulla & Chowdappa (2020) mentioned that self-learning is crucial for academic and professional growth, and the constant use of e-resources forces students to become self-reliant and learn from their surroundings. With information constantly flowing, mastering self-learning is essential for staying updated in their field. The survey used in our study examined students' inclination and ability to engage in self-learning beyond conventional classroom settings. It gauged their interest in autonomously studying for exams, completing assignments, and exploring content beyond prescribed curricula. Understanding students' attitudes towards self-learning assists institutions in promoting lifelong learning habits, equipping students to adapt to evolving information landscapes and self-educate in various domains. The survey questionnaire prepared for identifying the factors associated the self-learning ability of the students is as shown in Table I.

C. Theory Examination Performance

This survey targeted challenges faced by students during written exams and their preparatory phases. The questionnaire probed various aspects, including students' capacity to organize responses, manage time during exams, comprehend question nuances, grasp overarching concepts, and utilize diverse resources effectively. Assessing students' abilities to navigate mathematical subjects and tackle questions at varying cognitive levels offers insights into their critical thinking and problem-solving skills. This data informs instructional strategies aimed at improving exam performance and holistic understanding of subjects. The survey questionnaire prepared for descriptive theory examination is as shown in Table II.

TABLE I
SELF-LEARNING SURVEY QUESTIONNAIRE

Sr. No.	Survey Questionnaire
1	Which of these activities did you find most valuable for learning? (a)Reading (b) Writing (c) Speaking (d) Listening (e) Blended (f) Group work
2	How do you learn courses which are not understood during academics or advanced courses which are not in Syllabus? (a)Internet Sources (b) Text Book Reading (c) Group study
3	Do you like self-learning? (a)Yes (b) No
4	If Yes, which source do you use? (a) Online Course (b) Online Tools (c)YouTube Videos (d) Online Compliers (e) Research Papers (f) Both Online Course and YouTube (g) Online Course, YouTube, Online Tools, Research Papers (h) Using all the different options mentioned
5	How do you like to study? (a)Referring hard copy material (b) referring soft copy material (c) Referring Both hardcopy and softcopy materials
6	If Softcopy, which resource do you prefer? (a)ppt (b) pdf (c) Video (d) Animation (e) ppt or pdf whichever is best, sometimes animation too (f) pdf, video, animation (g) all the options
7	Online Courses are Beneficial for Learning? (a)Strongly agree (b) Agree (c) Neutral (d) Disagree (e) Strongly Disagree
8	Number of Online Courses Completed?

TABLE II
QUESTIONNAIRE FOR DESCRIPTIVE THEORY EXAMINATION SURVEY

Sr. No.	Survey Questionnaire
1	I feel difficulty in organizing the content while writing the answers in exams. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
2	I am unable to manage the time to write during examinations. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
3	I feel difficulty analyzing the exact meaning of the question asked. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
4	I am unable to elaborate the expected answer as per the scope of question asked. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
5	I am unable to see the big picture of the concept learned. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
6	I refer different resource material (book/e-book/ internet sites/ educational CDs/online courses etc.) to clear the concepts. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

7 My reading speed is slow.
(a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

8 I am unable to understand the mathematical concepts.
(a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

9 I am unable to recall the mathematical formulas.
(a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

10 I like mathematics.
(a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

D. Soft Skills

de Campos et. al. (2020) explored how soft skills are defined and their relevance to engineering field, emphasizing their impact on the readiness of fresh graduate engineers for the job market. In order to improve soft skills, Haritha and Rao (2024) gradually applied Kolb's Experiential Learning Theory to professional domains such as management, engineering, design, and law. It determined which learning styles were most prevalent in each field and examined how the cyclic model enhanced the personal development of management students. According to the study, professionals can develop critical soft skills for success by applying the theory step-by-step.

Soft skills, encompassing communication, leadership, and interpersonal abilities, have gained prominence in fostering well-rounded professionals. This survey delved into students' strengths and weaknesses in these areas. By gauging communication effectiveness, presentation skills, English language proficiency, and participation in discussions and competitions, institutions can offer targeted interventions to enhance students' employability and adaptability in collaborative work environments.

A soft skill related questionnaire survey was designed as in Table III.

TABLE III
SOFT SKILLS SURVEY QUESTIONNAIRE

Sr. No.	Questionnaire
1	Where are you most comfortable expressing your ideas? (a) You prefer to keep your ideas to yourself (b) Talking one on one (c) Planning and putting it in writing (d) Discussing them with a group of people (e) Giving a speech or a presentation
2	How do you usually participate in group discussions? (a) You usually prefer not to get involved (b) You listen and only speak when you have a suggestion (c) You get involved and interact freely with the group (d) You prefer to focus on helping people to reach the best decision (e) You lead the discussion and express your thoughts
3	How do you feel about speaking in front of a group? (a) You try to avoid it if at all possible (b) You like the idea but not the pressure it creates (c) You don't mind doing it, if you are able to plan (d) You will do it as long as it helps out in some way (e) You enjoy the opportunity to convey your ideas
4	While having a conversation in English, you: (a) Easily lose interest (b) Like to learn from other people (c) Actively take part but can get distracted (d) Enjoy sharing your views and opinions (e) Often lead the conversation
5	Whether you have asked questions in class or contributed to classroom discussions? (a) Never (b) Sometimes (c) Often (d) Very often
6	Used formal way of communication (e-mail, application, letter etc.) for any official issue. (a) Never (b) Sometimes (c) Often (d) Very often
7	Are your presentations Convincing and Surprising? (a) Never (b) Sometimes (c) Often (d) Very often
8	Have you done your personal SWOT analysis? (a) Never (b) Sometimes (c) Often (d) Very often
9	What are your positive traits regarding communication? (a) None (b) Confidence (c) Vocabulary (d) Grammar (e) Pronunciation (f) All
10	What tasks do you avoid doing because of a lack of confidence? (a) None (b) Sharing your ideas (c) Asking your doubts (d) Both
11	What fears do you have that may be holding you back from communicating in English? (a) Nothing (b) Fear of being judge (c) Fear of rejection (d) fear of perfection (e) Fear of being on stage
12	If you disagree with someone's opinion, what do you do? (a) Attempt to understand their point of view (b) Try to persuade them to agree with you (c) Avoid confronting them in case their feelings are hurt (d) Say nothing because you prefer to avoid an argument (e) Tell them that you disagree and say why
13	Which ONE of these characteristics MOST applies to you? (a) Persuasive (b) Helpful (c) Organized (d) Decisive (e) Shy or quiet
14	When working on a problem with other people, you: (a) Prefer to take the initiative and sort it out quickly (b) Try to find a collective solution (c) Let other people find the answer (d) Allow others to lead and help if needed (e) Devise a plan and look for ways to assist others
15	How do you feel about giving orders or instructions? (a) It's OK, provided you have proper justification (b) You prefer to collaborate with others, not give orders (c) You instinctively try to avoid it (d) You are wary in case there is any opposition (e) You are very happy to do it

E. Programming Skills

Blom & Saeki (2011) studied about the employability and skill set of newly graduated engineers in India. NASSCOM data shows that only about 25% of engineering graduates are employable. The IT industries are hiring students with good programming skills and technical skills. Two survey questionnaires were designed as shown in Table IV and Table V.

First survey for the basic programming level considering the foundation courses like C and C++ programming languages.

The participants were from Second Year B. Tech level students from the department. Second survey focus on advanced programming considering the application development at a higher level and conducted for Third Year B. Tech and Final Year B. Tech level students. In the first survey, the basic knowledge of programming like syntax and semantics of the programming, debugging of the programs and logical skills applying etc. are considered. For the second survey along with the basics of programming language, the application developer approach was considered.

TABLE IV
PROGRAMMING SKILLS SURVEY QUESTIONNAIRE- I

Sr. No.	Questionnaire
1	I am participating in the programming related competitions in the Institute or outside the Institute. (a) Within the institute (b) Outside the institute (c) Both in the institute and outside the institute (d) Never participate
2	I am able to apply the concepts learned in C/C++ programming in other courses like data structures, CN etc. (a) Yes (b) No
3	I am able to build the logic to solve given problem. (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
4	I am unable to recall the syntax of C/C++ languages. (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
5	I can able to debug the programs of C and C++ to resolve the syntax error and logical errors (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

TABLE V
PROGRAMMING SKILLS SURVEY QUESTIONNAIRE - II

Sr. No.	Questionnaire
1	I am able to develop the real time application/project using the programming languages. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
2	I am able to do user interface designing using programming languages. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
3	I am able to manage database using programming languages in application development. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
4	I am able to build the business logic to solve the problem. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
5	I am conversant with IDE of different languages. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
6	I want to learn advanced concepts and new languages used in the industries.

	(a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
7	I am able to answer the questions asked related to programming and concepts. (a)Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

The survey questionnaire was prepared based on factors such as UI designing, database management, business logic development. Participation of students in different technical competitions and responses to solve the real world/complex problems were taken into consideration for tracing the confidence level of students.

F. Research and Entrepreneurship Development (ED) Interest

Sustainable products, services, and technologies were needed for the growth and survival of today's engineering world. Samavedham & Ragupathi (2012) explored 21st-century students' knowledge and skills for modern engineers, like Creativity and innovation, Critical thinking and problem-solving, Communication, Collaboration, Information literacy, Technology usage, Career/Life Skills, Personal/Social responsibility. They focused on curriculum design, classroom practices, and assessment methods. Belmonte et al. (2022) looked into the factors that influence Philippine engineering students' decision to become technopreneurs. According to a survey of 200 students, technopreneurial intentions are significantly influenced by computer proficiency, capital availability, and entrepreneurial experience, while other factors had no discernible impact. The findings point to important areas that can influence aspiring technopreneurs.

21st Century engineers needed to train with creativity and innovation to come up with sustainable solutions. This will lead to curriculum designing with innovation and entrepreneurship and research contents. But still, there is less interest in opting the entrepreneurial courses and research-oriented courses. To check the research and entrepreneurship interest, the questionnaire was designed separately and given below as in Table VI and Table VII.

TABLE VI
RESEARCH INTEREST SURVEY QUESTIONNAIRE

Sr. No.	Questionnaire
1	I know about research methodologies. (a) Yes (b) No
2	I think my participation in research is important. (a) Yes (b) No
3	I have an interest in research but don't know process. (a) Yes (b) No
4	I am interested to develop a software product than writing research work. (a) Yes (b) No
5	I have contributed to _____. (a) Research (b) Idea presentation (c) Paper presentation

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6   I am familiar/involved with my teacher's research work.
(a) Never (b) Sometimes (c) Always

7   I would like to interact with researchers in community/institute.
(a) Never (b) Sometimes (c) Always

8   The research culture in institute encourages my learning process.
(a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

9   I know the recent developments in the research field.
(a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

10   Courses that I am studying encourages enthusiasm and personal interest about research.
(a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

TABLE VII
ENTREPRENEURSHIP DEVELOPMENT INTEREST SURVEY QUESTIONNAIRE

Sr. No.	Questionnaire
1	Entrepreneurship can be considered as a career option in today's globalized world. (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
2	I do not choose entrepreneurship because I feel it's risky. (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
3	I am not preferring entrepreneurship due to lack of finance. (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
4	I do not have enough ideas to convert into business opportunity. (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
5	I would rather be my own boss rather than work for someone else. (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
6	You are aware about the institute initiatives taken for entrepreneurship? (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree
7	I get the insights about the entrepreneurship through. (a) Strongly disagree (b) Disagree (c) Undecided (d) Agree (e) Strongly agree

- *Face validity for proposed method:*

As specified above in this section, there were seven survey questionnaires prepared. The face validity is applied for the designed questionnaire. Initially, a face validity form was prepared with the following questions.

i. Clarity of Questions: Do you find the wording of the questions clear and easy to understand?
(a) Yes (b) No

ii. Relevance of Questions: Do you believe that the questions asked are relevant to assessing your academic challenges, communication skills, programming knowledge, research interest, and entrepreneurial mindset?
(a) Yes (b) No

iii. Appropriateness of Response Options: Are the response options provided for each question comprehensive and appropriate?
(a) Yes (b) No

iv. Coverage of Key Areas: Do you feel that the survey covers all key areas related to your learning difficulties, communication preferences, programming skills, research involvement, and entrepreneurial interests?
(a) Yes (b) No

v. Consistency and Flow: Do the questions flow logically from one section to the next, and is the survey easy to follow?
(a) Yes (b) No

vi. Length and Time to Complete: Do you find the length of the survey appropriate, considering the depth of information being gathered?
(a) Yes (b) No

vii. Overall Impressions: Based on your understanding, do you believe this survey will effectively gather the information needed to assess your learning challenges, communication skills, programming abilities, research interests, and entrepreneurial mindset?
(a) Yes (b) No

The expert panel of 20 members who are the experienced faculty members from the Computer Science & Engineering and Information Technology Departments were finalized. Responses for the face validity forms were collected from the identified expert panel members. The percentage of agreement for each question and overall agreement was calculated. The acceptability of percentage of agreement was kept >90% for retaining the question and a small revision made if it is between 80-90%.
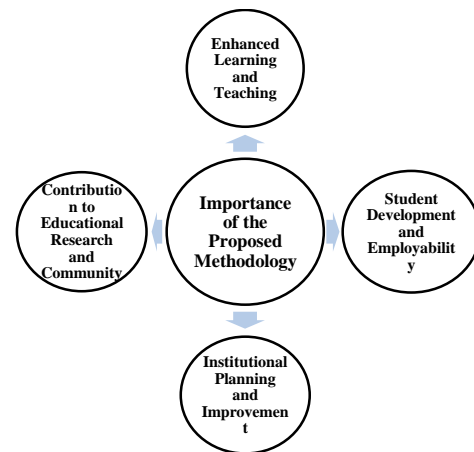
- *Importance of the proposed method*

Fig. 2. Importance of proposed method

Importance of proposed method is shown in Fig. 2 and elaborated below:

i. *Enhanced Learning and Teaching:*

- Beyond test scores, surveys record a variety of facets of students' growth. This makes it possible for teachers to modify their methods to accommodate various learning difficulties and styles, which enhances student engagement and comprehension.

- Survey results are used to inform the creation and improvement of curricula that meet the needs and trends of the industry. This guarantees that graduates have current knowledge and abilities, improving their marketability. Teachers can redesign assessments by taking into consideration time management, question formats, and content coverage after learning about the unique challenges that students encounter during exams. This encourages improved performance and creates a less stressful exam environment.

ii. *Student Development and Employability:*

- The surveys pinpoint students' strengths and shortcomings in both technical and soft skills. Institutions use this data to inform the development of focused training programs that improve students' problem-solving, communication, teamwork, and programming skills.

- Survey results give institutions information about which students might need more help. Academic counseling, workshops, or materials catered to each learner's preferences are a few examples of this individualized care.

- The design of specialized courses that foster creativity, problem-solving, and leadership abilities is informed by survey data on students' research and entrepreneurial interests. Graduates are better prepared to contribute to creative solutions across a range of domains.

iii. *Institutional Planning and Improvement:*

- Institutions are able to make well-informed decisions regarding faculty training, resource allocation, and strategic planning thanks to the combined survey data. This guarantees that institutional initiatives are in line with the requirements of students and current developments in education.

- Institutions promote a culture of continuous improvement by carrying out survey cycles on a regular basis. Over time, curriculum design, support systems, and teaching strategies can be improved and adjusted based on input from earlier surveys.

iv. *Contribution to Educational Research and Community:*

- The data collected from these surveys contributes to the broader body of educational research. Educators, researchers, and policymakers can use this data to gain insights into effective pedagogical practices, improving educational outcomes on a larger scale.

- Involving students in surveys demonstrates that their opinions and experiences are valued. This engagement fosters a sense of ownership and partnership in their educational journey.

- Survey insights can be shared with the wider academic community, promoting knowledge exchange and fostering collaboration among educational institutions. This extends the impact of the surveys beyond the individual institution.

IV. RESULTS AND DISCUSSIONS

The data was collected through the survey questionnaire from students belonging to the Computer Science and Information Technology department of an autonomous Engineering College in Southern Maharashtra. The following section discusses the observations and analysis of the responses collected from the students.

A. *Learning Style*

Students completed the feedback of the learning style questionnaire designed by Richard Felder, available at website *https://https://www.webtools.ncsu.edu/learningstyles/*. The report generated values have taken for the analysis.

Based on the students' survey, the scores for the dimensions of learning styles are calculated. This score for a dimension indicates a student's preference for one category or the other. If the score for a dimension is 1 or 3, the student is fairly well balanced with the two categories of that dimension, with only a mild preference for one or the other. If the score for a dimension is 5 or 7, the student has a moderate preference for one category of that dimension. The student may learn less easily in an environment that fails to address that preference at least some of the time than students would in a more balanced environment. If the score for a dimension is 9 or 11, the student has a strong preference for one category of that dimension. The student may have difficulty learning in an environment that fails to address that preference at least some of the time. Table VIII shows the percentage of students with the cumulative scores range of the dimensions of the learning styles.

TABLE VIII
STUDENTS CATEGORIZATION USING LEARNING STYLES

Score Range	Active-Reflective	Sensing-Intuitive	Visual-Verbal	Sequential-Global
1-3	51	57	21	66
5-7	31	23	44	16
9-11	18	20	34	18

It was observed that on average 23% of the students were having a score range of 9-11 in all learning dimensions. These students may feel difficulty in the learning environment which does not lead to their preference category. There is a need to develop the lesson plans and teaching activities using the active learning strategies addressing these categories of students so

that they will keep their interest in learning. The learning styles dimension of the class/student is an essential factor helpful for deciding the teaching-learning strategy by the teacher for better learning. This will lead to increasing the academic performance of the students.

Observations and Implications

- Offer a variety of learning activities that appeal to both groups within a dimension for students with scores in the 1-3 range (mild preference). Include opportunities for verbal and visual, sequential and global, sensing and intuitive, active and reflective, and learning preferences.

- Targeted learning activities that fit their preferred category may be beneficial for students with scores in the 5-7 range (moderate preference). To increase adaptability, provide a range of teaching strategies that emphasize the preferred style while sporadically incorporating aspects of the other style.

- Pupils who score between 9 and 11 (strong preference) have a clear preferred learning style that needs extra care. Create lessons that primarily address their chosen area of expertise to create a captivating educational experience.

B. Self-Learning Ability

The responses were collected from the students from all classes from the department for analyzing the student's interest in self-learning. The factors with the highest responses are presented in Table IX.

TABLE IX
ANALYSIS BASED ON SELF-LEARNING ABILITY

Sr. No.	Factors addressed by Questionnaire	Factors with highest score	Student's Response (%)
1	Activities most valuable for learning	• Group work • Listening	56 26
2	Tools used by students to learn contents beyond the syllabus or difficult concepts	• Internet Sources • Group Study	95 12
3	Preferred resources types used for self-learning	• Videos • Online Course • Documents	51.5 33 21
4	Preference for study resource format: Softcopy or Hardcopy	• Hard and Softcopy • Only Softcopy	90 15

It was observed from the analysis that students are techno-savvy. Students preferred to use both hard copy and soft copy resource material for learning. Students gave the highest preference (51.5%) to video resource usage for the learning. 33% of students opted to learn through online courses. They felt comfortable learning through group activities.

Observations and Implications:

- According to the analysis, students show a preference for digital resources and are at ease using technology. This implies that incorporating technology into instructional strategies can improve student engagement and suit their preferred methods of learning.

- The preference of students for multimedia, online courses, and videos highlights the value of providing a variety of resource formats. This improves the overall learning experience by accommodating various learning preferences and styles. The importance of collaborative learning environments is highlighted by the preference for "Group work" and "Group study." Peer discussions and group activities can promote a feeling of community and offer chances for knowledge and insight sharing.

- The potential for incorporating Massive Open Online Courses (MOOCs) into the curriculum is highlighted by the strong preference for "Internet Sources" and "Online Course." Students can benefit from a more comprehensive and adaptable learning experience when MOOCs are combined with traditional courses.

- Teachers can create learning modules that include multimedia materials like videos and online courses to foster students' capacity for self-learning. This method promotes self-directed inquiry and fits in with the preferences of the students.

- Teachers can provide a range of materials to accommodate varying preferences while preserving accessibility, taking into account the preference for both hardcopy and softcopy resources.

- Peer learning opportunities and students' self-learning journeys can both be improved by promoting collaborative learning through group projects, discussions, and activities.

C. Descriptive Theory Examination

The student's feedback associated with descriptive theory examination was analyzed based on the questionnaire as shown in Table II and obtained the following observations as shown in Table X.

TABLE X
SUMMARY OF DESCRIPTIVE THEORY EXAMINATION SURVEY

Sr. No.	Factors addressed by the Questionnaire	Student's Responses (in %)
1	Difficulty in organizing the content while writing the answers in exams.	62.8
2	Unable to manage the time to write during examinations	56
3	Difficult to analyze the exact meaning of the question asked	56.2
4	Unable to elaborate the expected answer as per the scope of the question asked	57

5	Unable to see the big picture of the concept learned	55.4
6	Unable to recall/understand/apply the mathematical concepts	40.9

6	Create something new by combining the parts to form a unique solution to the problems	Level 6 (Creating)	25.6

- A need for assistance in structuring responses is indicated by the high percentage of students who report having trouble organizing their content. Teachers can provide methods for structuring and delivering responses in a logical manner.

- It's critical to address time management issues. Teachers can offer advice on how to allocate time for various questions, practice time-bound practice tests, and develop time-conscious writing abilities.

- The challenge of deciphering question meaning emphasizes how crucial it is to develop question comprehension abilities. Teachers can provide strategies for breaking down questions and comprehending their needs.

- Teaching methods that prioritize critical thinking, making connections between ideas, and giving comprehensive explanations may help students who struggle to elaborate their responses.

- Teachers can use activities that illustrate the connections between ideas and their practical applications to help students who struggle to see the big picture.

- Students facing difficulties with mathematical concepts may benefit from targeted revision sessions, practice problems, and interactive learning resources.

- The collective insights emphasize the significance of a holistic approach to exam preparation. This includes not only content understanding but also time management, question analysis, and effective communication.

Following are the observation as a response towards which types of Bloom's taxonomy questions students could able to solve as shown in Table XI.

TABLE XI
SUMMARY OF BLOOM'S TAXONOMY SURVEY RESPONSES

Sr. No.	Question Type	Corresponding Bloom's Level	Students' Responses (%)
1	Recall the facts and basic concepts	Level 1 (Remembering)	60.3
2	Explain the concepts and ideas	Level 2 (Understanding)	59.5
3	Apply the concepts to solve the problems	Level 3 (Applying)	57
4	Analyze the data and write the observations	Level 4 (Analyzing)	47.1
5	Express own opinion or the values based on the expresses criteria, ideas or methods	Level 5 (Evaluating)	52.9

- Students have a strong foundation in remembering facts, concepts, and comprehending ideas, as evidenced by the comparatively high percentages for Bloom's Levels 1 and 2. This implies that Bloom's Taxonomy's early phases are adequately covered.

- A significant percentage of students (57%) demonstrated the ability to use concepts to solve problems. This suggests that a sizable portion of students have demonstrated proficiency in applying their knowledge, moving beyond simple recall and comprehension.

- According to the percentages for Bloom's Levels 4 and 5 (Analyzing and Evaluating), a sizable portion of students are able to write observations, analyze data, and express opinions. This suggests a degree of analysis and critical thinking.

- Bloom's Level 6 (Creating) had a lower percentage (25.6%), which suggests that fewer students were able to come up with original and creative solutions. This could point to a possible area where developing higher-order thinking abilities could be strengthened.

- The data points to a balanced distribution across several Bloom's levels, suggesting that a well-rounded curriculum incorporates both higher- and lower-order thinking skills.

- Teachers can accommodate students' varying Bloom's levels and encourage them to use a range of cognitive processes by incorporating a variety of question types into assessments.

- Teachers can include more activities that inspire students to innovate and combine ideas, which will stimulate higher-order thinking skills and improve creative thinking and problem-solving.

- The data implies that students are progressing through various cognitive levels, from remembering and understanding to applying, analyzing, and evaluating. This suggests a positive trajectory of skill development.

The pedagogical framework of an independent school embraces activity-based learning approaches and adheres to the tenets of outcome-based education (OBE). A combination of End Semester Exams (ESE), which include conventional written assessments for theory-oriented courses, and In Semester Exams (ISE), which use a range of evaluation techniques, are used to assess students' progress. The ESE theory papers were initially given 50 marks, or 50% of the total ESE score. But later changes to the exam format led to the reformatting of ESEs to include theory tests worth 100 points, with the same 50% weighting in the ESE component. Following the adoption of this modified examination pattern, this survey was carried out.

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A thorough examination of the gathered data reveals that the evaluation techniques used successfully cover the whole range of Bloom's Taxonomy levels. But an interesting finding emerges: students are significantly less confident when answering written exam questions that align with Bloom's Level 4 (Analyzing) and Level 6 (Creating). Their ability to understand the full context of the ideas they have studied is greatly impacted by this phenomenon. Students' inability to effectively respond to Bloom's Level 4 (Analyzing) questions reflects their difficulties breaking down complex information, identifying relationships, and extracting patterns from complex data. Their difficulties answering questions related to Bloom's Level 6 (Creating) also suggest that they are limited in their ability to combine unique concepts and come up with creative answers. All of these limitations make it harder for them to understand how various conceptual components are more broadly interconnected.

D. *Soft Skills*

To collect the responses about the positive traits and weaknesses related to student's communication, presentation, English communication, leadership skills etc., a soft skill related questionnaire survey was designed as in TABLE III. The observations and analysis are as described below.

Among the students, specific patterns surfaced in the context of English communication. Interestingly, a significant 18.4% of the students reported a fear of being judged when speaking in English, 3.7% reported a fear of perfection, and 7% reported a fear of rejection. Notably, 23.7% of students said that they are afraid to ask questions or share their thoughts. This reluctance to participate points to possible areas for enhancing confidence and creating a more welcoming classroom atmosphere. According to the data, 28% of students tend not to actively participate in group discussions. Rather, they choose to listen passively or make very little contribution. This finding highlights differing levels of comfort with communication dynamics and group engagement.

One noteworthy finding was that only 31% of students think they have all the positive communication qualities, such as vocabulary richness, confidence, grammar proficiency, and clear pronunciation. In particular, only 30.7% of students said they could communicate confidently. According to the data, a noteworthy 40% of students find it difficult to voice their opinions in front of others. Their capacity to effectively participate in conversations and projects may be impacted by this reluctance. About 47.4% of students acknowledged that they had become sidetracked or lost interest during interactions. Nonetheless, some students appear to gain knowledge from the contributions of their peers, demonstrating a benefit of group learning. About 54% of students reported using formal communication (written or verbal) either infrequently or never.This insight suggests a diverse range of communication preferences and habits among students.

In light of this analysis, several key traits emerged as influential factors in shaping students' soft skills:

- The results of the survey highlighted the existence of fear-related difficulties that impact students' participation and communication. This emphasizes how crucial it is to foster confidence-boosting techniques in learning environments.

- The reluctance to actively participate in group discussions and exchange ideas highlights the need for tactics to promote increased participation, cooperation, and inclusivity in the classroom.

- Indirectly, the data showed that students' leadership and presentation abilities varied. By addressing these issues, they will be better equipped to lead group projects and effectively communicate ideas.

- The disparity in formal communication usage emphasizes how crucial it is to teach students both formal and informal communication techniques in order to prepare them for a variety of situations.

- The observations about group participation shed light on group dynamics, indicating room for cultivating effective group communication and decision-making skills.

E. *Programming Skills*

The first survey was conducted for the S. Y. B. Tech students, considering the foundations of programming languages learned by them. The observations are summarized in Table XII. The second survey was conducted for the T. Y. B. Tech and Final Year B. Tech students, considering the advanced programming languages learned by them. The observations are summarized below in Table XIII.

TABLE XII
SUMMARY OF PROGRAMMING SKILLS- FIRST SURVEY
RESPONSES

Sr. No.	Factors addressed by Questionnaire	Corresponding Bloom's Taxonomy Level	Student's Responses (%)
1	Recall the syntax of C/C++ languages	1	68
2	Debug the programs of C/C++ to resolve the syntax error and logical errors	3,4	56
3	Participating in programming-related competitions in the Institute or outside the Institute.	3,4,5,6	32
4	Apply the concepts learned in C/C++ in other courses like data structures, CN, etc.	3	84
5	Build the logic to solve given problem	4,5,6	44

Following are the observations from the survey responses.

- Syntax Recall: Approximately 68% of students are comfortable remembering the syntax of the C/C++ languages. This is in line with Bloom's Level 1

(Remembering), which deals with the fundamental capacity to retain and replicate knowledge. This data point indicates that most students have a strong foundational understanding of the syntax of programming languages.

TABLE XIII
SUMMARY OF PROGRAMMING SKILLS- SECOND SURVEY
RESPONSES

Sr. No.	Factors addressed by Questionnaire	Corresponding Bloom's Taxonomy Level	Student's Responses (%)
1	Develop the real-time application/project using the programming languages.	5,6	77
2	Design user interface using programming languages.	3,6	86
3	Manage databases using programming languages in application development.	3	75
4	Build the business logic to solve the problem.	3,4	55
5	Conversant with IDE of different languages, open-source tools	3	66
6	Learn advanced concepts and new languages used in the industries.	5, 6	79
7	Answer the questions asked related to programming and concepts.	1,2,3	74

- Debugging C/C++ Programs: About 56% of students said they were proficient in fixing logical and syntactic errors in C/C++ programs. This demonstrates that students have the ability to apply concepts and analyze code to find and fix errors, which is consistent with Bloom's Levels 3 (Applying) and 4 (Analyzing). Though not all students find this task easy, there is still opportunity for improvement.

- Programming Competition Participation: Approximately 32% of students participate in programming competitions, indicating their readiness to use their abilities in competitive environments. This demonstrates a wide range of cognitive abilities and is consistent with Bloom's Levels 3 (Applying), 4 (Analyzing), 5 (Evaluating), and 6 (Creating). Increasing student participation can support the development of higher-order thinking and problem-solving skills.

- Use of Concepts in Other Courses: A noteworthy 84% of students said they had used C/C++ concepts in other classes, demonstrating a solid understanding of real-world implementation. This supports students' ability to apply their programming knowledge in a variety of contexts,

which improves cross-disciplinary comprehension and is consistent with Bloom's Level 3 (Applying).

- Logic for Solving Problems: About 44% of students demonstrated proficiency in developing logic for solving problems. This covers Bloom's Levels 4 (Analyzing), 5 (Evaluating), and 6 (Creating), demonstrating students' capacity to assess possible solutions, analyze problems, and even come up with original solutions. This indicates a respectable level of mastery of higher-order thinking abilities associated with programming problems.

- Create Real-time Applications/Projects: According to 77% of students, they can use programming languages to create real-time applications or projects. Bloom's Levels 5 (Applying) and 6 (Creating) correspond to this competency. These findings show that students have a significant practical aptitude for converting their understanding of programming into real-world applications, showcasing their capacity for innovation and implementation.

- Create User Interfaces: Approximately 86% of students said they could use programming languages to create user interfaces. This ability suggests that students can use design principles to create user-friendly interfaces, which is in line with Bloom's Levels 3 (Applying) and 6 (Creating). This high proportion suggests that students are highly proficient in this crucial area of software development.

- Handle Databases in Application Development: Approximately 75% of students said they were proficient in database management when using programming languages in application development. This ability demonstrates students' ability to practically integrate database management into their programming projects and is linked to Bloom's Level 3 (Applying).

- Develop Business Logic: Approximately 55% of students reported being adept at using business logic to solve problems. Bloom's Levels 3 (Applying) and 4 (Analyzing) are involved in this factor, showing that students are able to apply logical constructions and analyze scenarios for efficient problem-solving. But there is still opportunity for development, especially in the analytical area.

- Knowledge of IDEs and Open-Source Tools: Sixty-six percent of students said they were familiar with open-source tools and Integrated Development Environments (IDEs). This competency highlights students' practical competence in using key tools in the programming workflow and aligns with Bloom's Level 3 (Applying).

- Learn New Languages and Advanced Concepts: A noteworthy 79% of students said they wanted to learn new programming languages and advanced concepts that are applicable to various industries. Bloom's Levels 5 (Applying) and 6 (Creating) are in line with this goal, which demonstrates students' proactive approach to

ongoing skill development and flexibility in response to shifting market demands.

- Respond to Programming-Related Questions: Roughly 74% of students said they could respond to questions about programming and related ideas. This skill demonstrates a comprehensive understanding of theoretical knowledge and practical application, spanning Bloom's Levels 1 (Remembering), 2 (Understanding), and 3 (Applying).

F. Research and Entrepreneurship Development Interest Analysis

1) Research Interest

The research interest feedback was collected by all the students from the department and the statistics are as shown in Table XIV. Students are less interested in the research work. Even though there was a separate track for the research in institute, students were shy away from research track.

TABLE XIV
SUMMARY OF RESEARCH INTEREST SURVEY RESPONSES

Sr. No.	Factors addressed by Questionnaire	Student's Responses (in %)
1	Know about research methodologies	40
2	Participation in research is important	60
3	Have an interest in research but don't know the process	49
4	No interest to develop a software product than writing research work	2
5	The research culture in the Institute encourages my learning process	8
6	Know the recent developments in the research field	3
7	Courses that I am studying encourage enthusiasm and personal research interest.	4
8	Familiar/involved with teacher's research work	3
9	Like to interact with researchers in the community/institute.	23

Following are the observations based on the analysis:

- Approximately 40% of students said they were familiar with research methods. This implies that a sizable percentage of students comprehend the procedures involved in carrying out research. To give more students strong research skills, this area could be improved.

- About 60% of students said that taking part in research is important. This suggests that students have a good understanding of the importance of research projects and

how they can influence both academic and personal development.

- Approximately 49% of students said they were interested in conducting research but were unclear about how to go about it. This indicates a readiness to participate in research-related activities, but it also emphasizes the need for additional direction and instruction regarding research methods.

- Just 2% of students said they were more interested in writing research papers than creating software products. This data point emphasizes how much the students surveyed preferred research projects over software development.

- Just 8% of students thought that the institute's research culture supported their educational journey. This implies that a sizable percentage of students' learning needs and goals may not be fully met by the institute's research environment. Roughly 3% of students said they were aware of the latest advancements in the field of study. This low percentage suggests that only a small portion of students are staying current with developments in their field of study.

- Approximately 4% of students believed that their classes actively foster passion and individual research interests. This suggests that only a small percentage of students believe that their present classes encourage research curiosity.

- Knowledge of Teachers' Research: Approximately 3% of students said they were familiar with or involved in their teachers' research. According to this data point, very few students are participating in the ongoing research projects of faculty members.

- Interest in Communicating with Researchers: About 23% of students said they would like to communicate with researchers at the institute or community. This suggests a readiness to interact with experts who are actively conducting research.

The data analysis reflects a diverse range of attitudes and perceptions among students regarding research-related aspects. While there's a notable recognition of the importance of research participation and interest in research, there are areas where the institute's research culture, guidance, and exposure to recent developments can be further enhanced. Providing more opportunities for students to engage with faculty research, fostering a supportive research environment, and offering educational initiatives on research methodologies could contribute to nurturing a robust research culture and facilitating students' active involvement in research-related pursuits.

2) Entrepreneurship Development Interest

The Entrepreneurship Development (ED) interest survey was collected by all the students from the department and the statistics are as shown in Table XV.

TABLE XV
SUMMARY OF ED INTEREST SURVEY RESPONSES

Sr. No.	Factors addressed by Questionnaire	Student's Responses (%)
1	Entrepreneurship can be considered as a career option in today's globalized world	75
2	Do not choose entrepreneurship because of risk	27
3	No preference for entrepreneurship due to lack of finance.	32
4	Do not have ideas to convert into a business opportunity	28
5	Feel that being an own boss rather than work for someone else	53
6	Aware of the institute initiatives taken for entrepreneurship	81
7	Got insights about entrepreneurship through (ED courses, Alumni expert lectures, ED cell activities, family business)	42

Following are the observations based on the analysis of survey taken on Entrepreneurship interest.

- Entrepreneurship as a Career Option: In today's globalized world, about 75% of students believe that entrepreneurship is a feasible career option. This high percentage shows that students significantly recognize the value and potential of entrepreneurship as a career path.

- Risk Aversion in Entrepreneurship: Approximately 27% of students said that they did not choose entrepreneurship because they were afraid of the risks. This implies that a sizable percentage of students are hesitant to pursue entrepreneurship because of the unknowns and possible difficulties involved.

- Financial Constraints and Entrepreneurship: About 32% of students said that they did not want to pursue entrepreneurship because of financial limitations. This statistic emphasizes how critical it is to address financial issues and offer aspiring student entrepreneurs support networks.

- Absence of Business Ideas: Approximately 28% of students said they lacked ideas for potential businesses. This implies that students' creativity and idea generation need to be encouraged, possibly through workshops and ideation sessions.

- Desire for Independence as an Entrepreneur: Approximately 53% of students said they would rather be their own boss than work for someone else, which reflects their preference for entrepreneurship. This implies a strong desire for the independence and authority that come with being an entrepreneur.

- Knowledge of Institute's Entrepreneurship Initiatives: A noteworthy 81% of students said they were aware of the institute's entrepreneurship initiatives. This high percentage shows that students are aware of and supportive of the institute's efforts to encourage entrepreneurship.

- Sources of Entrepreneurship Insights: Approximately 42% of students obtained knowledge about entrepreneurship from a variety of sources, such as family businesses, ED cell activities, alumni expert lectures, and entrepreneurship development (ED) courses. This implies that students are learning about entrepreneurship by utilizing a range of resources.

The factors identified affecting the entrepreneurship are less creativity, less interest in ED, financial risk factor, no productive ideas and leadership skills.

CONCLUSION

The study demonstrated the use of a comprehensive approach to determine the elements influencing the development of undergraduate engineering students. The study sought to identify factors influencing student growth through a questionnaire that covered learning style, self-learning approach, soft skills, descriptive theory examination concerns, programming skills, research, and entrepreneurial interests. The study demonstrated the complex interactions between both favorable and unfavorable elements that affect students' growth. Good qualities like technological savvy, aptitude for self-learning, teamwork, UI design, communication, programming, and application development techniques were found to be important success factors.

On the other hand, student performance was found to be hampered by negative factors such as poor time management during exams, analytical deficiencies, difficult problem-solving obstacles, mathematical knowledge gaps, limited creative and logical skills, lack of global learning perspective, decreased confidence, fear of judgment and public speaking, poor presentation and leadership skills, lack of research and entrepreneurial interest, lack of productive ideas, and risk aversion. These results offer a guide for creating calculated interventions. Educational institutions can customize teaching-learning strategies that support students' growth and meet their individual needs by utilizing the positive and negative traits that have been identified.

The difficulties can be lessened by fostering an environment that values research and development, and students can stay up to date on changing trends by participating in activities that raise awareness of new developments. Furthermore, risk-taking and a growth mindset are fostered by motivational programs, which are essential for research and entrepreneurial endeavors. Future research should include more validations, like construct validity, to increase the survey instrument's generalizability. Creating an ecosystem rich in research and development culture can mitigate the challenges, while incorporating activities that promote awareness of recent updates can keep students abreast

of evolving trends. Additionally, motivational programs can nurture a growth mindset and encourage risk-taking, vital for both research and entrepreneurial pursuits.

To improve the generalizability of the survey instrument, future work should incorporate additional validations, such as construct validity.

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