

**Research Skills Future in Education:
Building Workforce Competence**

Research Report 1

**Do We Cultivate Research Skills?
Veracity versus Falsity**

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This new research project, 'Research Skills Future in Education: Building Workforce Competence', is a joint collaborative research endeavour involving researchers from India and the United Kingdom (UK). We are pleased to present the first research report from this project, gathering evidence from (largely) engineering undergraduate and postgraduate students that relates to the overarching question of 'Do we cultivate research skills? Veracity versus falsity'.

Acknowledgements

The authors would like to thank most sincerely the students who were willingly and openly involved in this study and who provided invaluable evidence for this report. Individuals and their institutions are not identified, to conform to ethical needs placed on reports of research of this nature - this should in no way be seen as devaluing the commitment and contribution played by all involved.

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1. Executive Summary

“The students do not have research skills although we are trying to imbibe it through term papers, minor projects, major projects, capstone projects, etc. As stated, the quality of graduates in India is not up to the mark. We could probably say that our curriculum and instructional pedagogies are not focused towards imbibing such skills. Hence, the skills remain superficial and rudimentary. The faculty primarily focus on imparting subject knowledge and ensure that the students pass the examinations but fail to understand the importance of research skills and do not focus on inculcating those skills.”

This reflection from a tutor in a higher education institution in India was our starting point. We wanted to find out the extent of understanding of research skills by students in India, and what their views were about the importance and place of research skills in their curriculum.

This document reports our findings, from students of engineering in the Delhi National Capital Region of India. So far, these findings support the view expressed by the tutor in the statement above. We argue that there is an urgent need to reconsider the position of research skills in the curriculum.

We offer some initial recommendations, and outline the next stages of our research, which will bring forward more fundamental understanding of this important topic.

Keywords: research skills, research skill integration, higher education, research elements, research knowledge, teaching research skills, curriculum

2. Introduction

Research is important for any country's economic development (Romer, 1987; Romer, 1990a; Romer, 1990b; Aghion & Howitt, 1992; Grossman & Helpman, 1991; Barro & Sala-i-Martin, 2004; Khan & Rehman Khattak, 2014). Research leads to inventions, innovations and creation of new technologies and products that can help improve and solve a variety of political, socio-economic, cultural, technological, and environmental issues (Blackburn, Huang & Pozzolo, 2000). But research requires human resources to have requisite skills and knowledge (Frantzen, 2000). Higher education has a key role to play in the creation and dissemination of that knowledge, imparting necessary research skills to students and preparing them for the knowledge society. Consequently, research skills have been identified by higher education institutions as one of the important graduate attributes that need to be imbibed among and used by students. Indeed, the development of research skills is continuously being considered as “an underlying principle” of undergraduate programmes (Katkin, 2003), as stated in the Boyer Commission Report (1998) and its impact on undergraduate research. Following the Boyer Commission recommendations on making research-based learning the standard, a number of universities began to integrate research at the undergraduate level (Boyer Commission, 1998; Shanahan et al., 2015). Subsequently, course elements such as term papers, capstone projects, major projects, independent research study, dissertations, and so on, have been introduced into the curriculum to enhance students' research skills. For example, as shown by these online resources:

- http://wscuc.ucla.edu/wp-content/uploads/2017/09/CPR_Essay5.pdf (UCLA, 2007) - shows the capstone approach taken to undergraduate education in this university, with the options available, involving students in undertaking research projects or seminars, for example;
- http://wscuc.ucla.edu/wp-content/uploads/2017/09/EER_Final.pdf (UCLA, 2009) - includes a chapter that discusses the outcomes of the capstone approach, where students were involved in writing research papers, giving research seminars, or undertaking research projects;
- <https://www.ashland.edu/mahg/programsma-american-history-and-government/thesis-and-capstone-projects> (Ashland University, 2018) - states that a research methods seminar is the first element of an MA programme, and students are supported by a research methods instructor;
- https://www.uts.edu.au/sites/default/files/Student_guide_to_capstone_project.pdf (UTS, 2017) - states the extent of support that students will gain when they undertake a capstone project, and the learning outcomes that should arise;
- <http://arrow.dit.ie/cgi/viewcontent.cgi?article=1079&context=beschrecon> (Daly & Scott, 2011) – this published conference paper discusses from tutor and student reflections the value of dissertations in an undergraduate programme;
- https://www.heacademy.ac.uk/system/files/resources/Students%20as%20researchers_1.pdf (Walkington, 2015) – this policy and practice resource provides evidence about the approaches that can be taken to developing students as researchers, and what outcomes can arise; and

- <https://www.aacu.org/publications-research/periodicals/undergraduate-research-high-impact-student-experience> (Lopatto, 2010) - this report provides evidence of student feedback following their involvement in undergraduate research, highlighting the wide array of outcomes, beyond immediate subject knowledge outcomes, that can arise.

In some of these cases, it is clear from their descriptions that these course elements are only a source of assessment of students' research skills; so it is not clear whether students are actually given an appropriate direction for pursuing research, or whether they are taught how to pursue research. Despite the skills imparted through these research-based courses, if no guidance or teaching is accessible to students, then the quality of research at graduate level may not be at a high level. Even if students are actually not taught research by their faculty mentors, it might be argued and assumed that the students will develop research skills on their own. However, certainly for effective and outcome-driven/outcome-based research, it is essential that these skills are imbibed in the students by their faculty. There are a number of studies (Feldon et al., 2015; Shanahan et al., 2015; Kuh, 2008) that emphasise the importance of faculty mentoring for embedding research skills among students. But the question arises as to whether the faculty really understands their role as a mentor when discussing about research-based/research-oriented projects. It can be argued that the faculty mentors might assume their role as an evaluator of students' progress and ignore their role as a teacher of research skills. Hence, in this instance, students gain whatever they can on their own for completion of their projects. Therefore, it might be the case that the students do not have all the skills required for conducting effective research.

Our current research study has explored this hypothesis (that the faculty mentors assume their role as an evaluator of students' progress and ignore their role as a teacher of research skills) by conducting a relevant survey of Indian higher education institutions. The research behind this report was designed to identify:

- a) whether students have basic research skills;
- b) what kinds of research skills the students currently have;
- c) whether the students are taught research skills;
- d) whether students feel that research should be part of their curriculum and credit system;
- e) whether students feel that teaching research skills would improve their scientific rigour;
- f) whether students feel that teaching research skills would improve their learning outcomes; and
- g) how they would self-assess their own research skills.

The fundamental aim of the study reported here was to help determine the current research knowledge of students and subsequently emphasise how important it might be to imbibe such skills among students by faculty through appropriate curriculum design and instruction.

3. Literature Review

The literature review was undertaken using the following keywords for the search: research skills; research skills higher education; research skills engineering students; research skills Indian higher education; teaching research skills. The search engines used were google.com, scholar.google.com, and the EBSCO database.

Scanty literature can be found that explains what research skills are and how they might be defined and characterised, even though details of how to conduct research within specific disciplines at a post-graduate or doctoral level can be commonly found. Research skills encompass both problem solving and information skills; one online article (Badke, 2012) characterises research skills as the capability to recognise a problem, identify the right source of information required to respond to the problem, search those sources efficiently, assess the quality and relevance of the collected information, and use the information effectively to tackle the problem. These skills are complex and higher order tasks, so sufficient or extensive time and effort are needed to cultivate them. According to Easterby-Smith et al. (2002), attributes of an effective researcher include: diverse knowledge and capabilities such as knowledge of their discipline and related sub-areas; understanding of philosophical issues; searching skills; knowledge of research methods and capability to apply them; knowledge of various data collection methods; abilities to obtain data as well as apply qualitative and quantitative techniques for data analyses; rhetorical skills for creating a persuasive and logical argument; written and oral presentation skills; computer skills; planning and time management skills; capabilities to work in collaboration; abilities to develop contacts; and abilities to continuously improve to find new ways of solving problems. According to Thomas (2004), qualities to handle these skills demand that a researcher should be self-critical, aware of his own strengths and weaknesses, devoted, creative, novel, and innovative. For research-based learning, the Boyer Commission emphasised the need for inquiry-based and collaborative learning for development of critical thinking as well as imbibing written and communication skills among students (Boyer Commission, 1998). Quarton (2003) laid down the importance of information literacy skills in this context. Indeed, to imbibe research skills, authors have stressed that students should undertake capstone projects (Boyer Commission) and class-based research projects (Moore & Teter, 2014).

The benefits of incorporating research at undergraduate level have been discussed by a number of authors (for example, Shanahan et al., 2015). Murtonen (2008) observed that students who considered research skills significant for their future work were more task-oriented and used a deeper approach to learning and experienced fewer difficulties in the learning of research skills than other students. It was argued that if the students were given better research experiences and orientation, the students might be better prepared for their future work. Another study indicated that undergraduate students were aware of the benefits of research experience and felt that a better understanding of the research process might improve their skills (Murdoch-Eaton et al., 2010). A number of studies have been conducted to showcase how research skills among medical students could improve their job opportunities (Murdoch-Eaton et al., 2010; Nikkar-Esfahani et al., 2012), while some studies have been conducted that show that teaching

improves research skills of students (Mariani et al., 2013). Many universities in the United States (US) and the United Kingdom (UK) emphasise the publication of student research and development of student research journals.

Very few studies have been conducted to assess the research skills of students. One such study was conducted by Murdoch-Eaton et al. (2010) to evaluate research skills of medical students through assessment of student projects in four areas - research methods, information gathering, critical analysis and review, as well as data processing. An analysis of 905 projects revealed that 52% of projects provided opportunities for students to develop one or more skills, while only 13% offered development in all areas. In 17% of cases, project descriptions provided insufficient information to determine opportunities.

Several authors have provided different strategies to develop research skills. They have focused on faculty mentorship as a way to impart research skills and argue that the quality of research conducted by students depends on the quality of mentoring they receive (Feldon et al., 2015; Shanahan et al., 2015; Kuh, 2008).

Though the literature highlights the importance of research skills and the importance of faculty mentorship for imbuing such skills, it is important to consider the role of faculty mentors in developing such skills. The question arises as to whether one needs to consider the kind and extent of guidance provided by faculty mentors, for example. Are faculty mentors actually imbuing the skills in their students or restricting their responsibilities to assessing their students?

There is literature on the development of research skills among management students and medical students, but no studies that have been found that have focused on engineering graduates. Overall, there is very limited work done in the area to assess the research skills of students, and not in an Indian context. To identify and help to address this gap, this study was conducted, which gathered evidence from undergraduate and postgraduate (largely) engineering students from the Delhi National Capital Region of India. The study was conducted across different levels of students, starting in their first year and moving to their fourth year. Assessment of first year findings is expected also to help to identify if students were mentored in their primary and high schools.

4. Methodology and Methods

From the gaps identified in the literature review, the following research questions were identified as worthy of exploration within an empirical study:

- (a) Are students aware of the term “Research”?
- (b) What do the students understand by “Research”?
- (c) Have students ever been taught research skills? If they were, at what level?
- (d) Do students feel that they have research skills? If yes, what kind of research skills do they feel they possess?
- (e) Do students feel that research skills are useful?
- (f) Do students feel that research skills should be part of the curriculum? If yes, how much percentage of the curriculum should research skills comprise?
- (g) Do students feel that if research is added to the credit system, it would improve learning outcomes?
- (h) Do students feel that research skills can be integrated through teaching?
- (i) Do students feel that research skills will enable them to conduct scientific research?
- (j) Do students feel that faculty need training in teaching research skills?
- (k) How do students rate themselves on different research skills, on a scale from 1 to 5?

The study undertaken was exploratory and descriptive. It was exploratory as it aimed to investigate whether students felt they had research skills, the extent of research skills they had and if students had been taught research skills. The study was descriptive as the research aimed to describe the present state of research skill instruction and use among students.

In order to fulfil the research objectives and find answers to the research questions, a quantitative research method was used. A bespoke questionnaire was designed, consisting of both closed-ended and open-ended questions. The questionnaire consisted of single-items, multiple items and five-point Likert scale items. The measurement scales were nominal, ordinal and interval. A sample of approximately one thousand students pursuing undergraduate, postgraduate or doctoral courses, and belonging to different domains and years was identified. Stratified random sampling was used to select samples. A pilot study was undertaken to remove ambiguities and to improve the research instrument. The subsequent survey was conducted online, and all students were informed of the study purpose, and volunteered to complete the survey. One hundred and sixty (160) responses were obtained by March 2017. The survey was conducted across higher educational institutions located in the Delhi National Capital Region of India.

5. Data Analysis and Findings

It is not possible to identify specific institutions from which responses were gained, but it is possible that these could have come from a few institutions, or from a small number of students within a wider range of institutions.

The sample population

Out of a total 160 responses by March 2017, the following numbers of responses were received from each subject domain (also see Figure 1):

- Humanities : 3.
- Social sciences: 1.
- Engineering: 156.

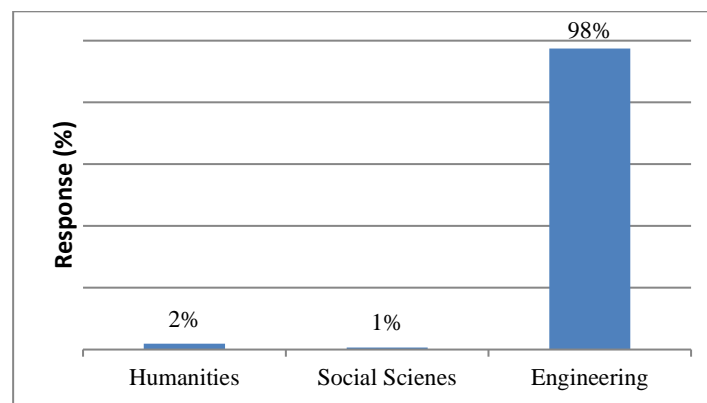


Figure 1: Responses by Subject Domain (in %)

Due to the very low response rate from the humanities (2%) and social sciences (1%) subject domains, the responses from these two domains were omitted and thus, only engineering (98%) responses were taken forward for further investigation. From this point on, the data and findings will refer to the engineering subject domain only.

The number of responses from each year of engineering education was (see also Figure 2):

- Year 1: 4 (3%).
- Year 2: 51 (33%).
- Year 3: 43 (28%).
- Year 4: 55 (35%).
- 3 respondents did not disclose the year in which they were studying.

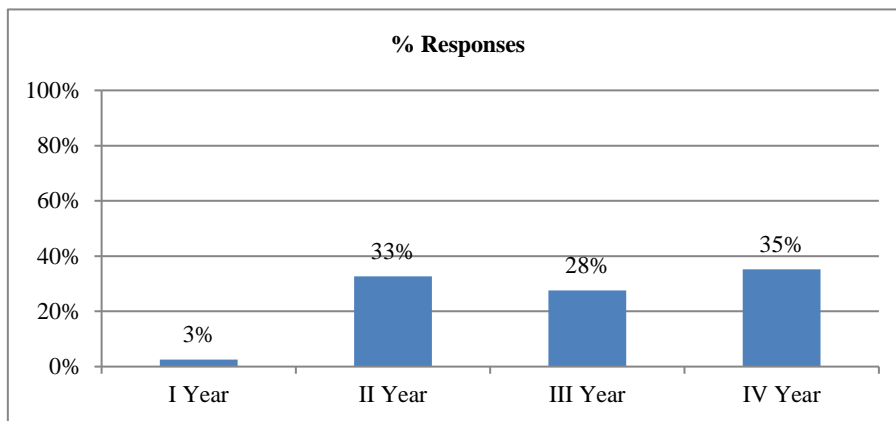


Figure 2: Responses by Year (in %)

The number of respondents at different education levels was (see also Figure 3):

- Undergraduate: 57 (37%).
- Postgraduate: 6 (4%).
- Doctoral: 1 (1%).
- No Response: 92 (59%).

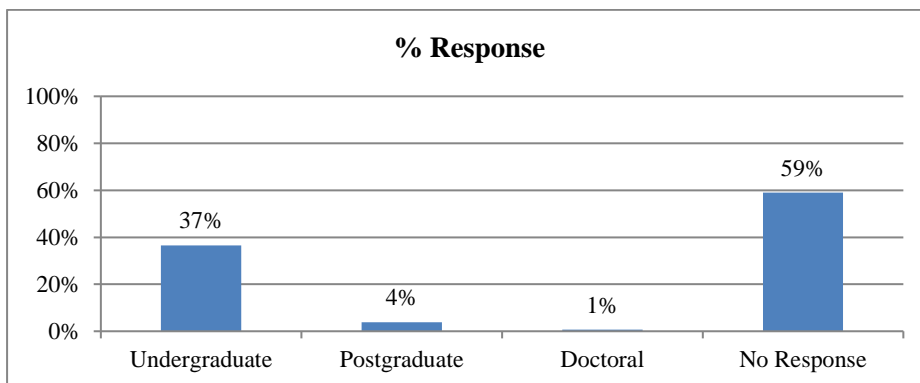


Figure 3: Responses by Level (in %)

Findings from this sample

Research Question 1: Are the students aware of the term “Research”?

Of the total respondents, 119 students (76%) reported that they were aware of the term “Research”, while 37 students (24%) indicated they had never heard about it, presumably from their courses (see Figure 4).

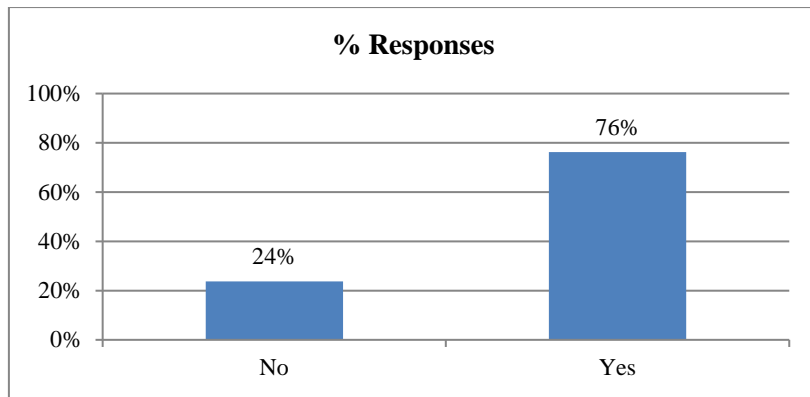


Figure 4: Responses on Awareness of the Term Research (in %)

The students who gave *No* responses, were in:

- Year 1: 0 (0%).
- Year 2: 14 (35%).
- Year 3: 11 (30%).
- Year 4: 13 (35%).

The students who gave *Yes* responses (see Figure 5) were in:

- Year 1: 4 (3%).
- Year 2: 38 (32%).
- Year 3: 32 (27%).
- Year 4: 42 (35%).

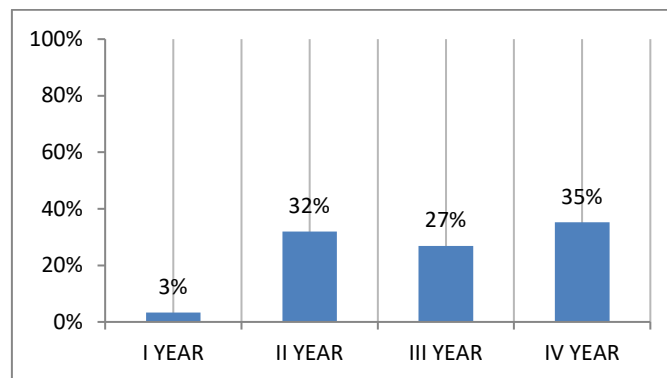


Figure 5: 'Yes' Responses by Year (in %)

Though most of the students were aware of the term, there were a considerable number of students who said they had no idea about research and it might be assumed that they have no research skills. If more data is collected from a larger number of institutions and wider population, it will be possible to see if the number of *No* responses continues to be significant.

Research Question 2: What do students understand by “Research”?

To gain an answer to this research question, the students were asked: What would you say are the three most important elements of research? This was an open-ended question. The students gave diverse answers and used a range of different terms. Though they used different terminology, many of them were related by core descriptors and had a common meaning. Hence, it was felt that their meaning could be understood and so one keyword was used to identify their response. Thus, sentences and phrases with related keywords with similar meaning were clustered and given a common keyword. These clustered responses for the first, second and third elements are shown in Table 1. In Table 1, keywords are ordered alphabetically rather than being ranked according to response levels.

Table 1: Research Elements reported by Students

FIRST ELEMENT		SECOND ELEMENT		THIRD ELEMENT	
Keywords	#	Keywords	#	Keywords	#
Aims & Objectives	9	Accuracy	1	Accuracy	3
Analysis	2	Aims & Objectives	5	Aims & Objectives	2
Association	1	Analysis	6	Application	1
Credibility	1	Association	3	Association	3
Data Collection	4	Authenticity	1	Conclusion	9
Discipline	4	Consistency	1	Content	1
Exploring/Exploration	4	Content	2	Critical Questioning	1
Idea	1	Content Flow	1	Data Collection	3
Innovation	6	Creative Thinking	3	Dedication	9
Interest	4	Data Collection	2	Depth	2
Introduction	9	Dedication	6	Discipline	1
Knowledge	29	Exploring/Exploration	3	Errors	1
Literature Study/Survey	9	Feasibility Study	1	Exploring/Exploration	3
Methodology	4	Follow-ups	1	Future Scope	2
Motivation	1	Guidance	2	Guidance	4
Originality	1	Idea	2	Idea	3
Problem Statement	4	Implementation	3	Implementation	3
Resources	3	Innovation	2	Interest	1
Searching	1	Interest	5	Knowledge	5
Significance Of The Study	2	Jot Down Your Research	1	Literature Study/Survey	4
Simplicity	1	Knowledge	13	Methodology	7
Synopsis	1	Literature Study/Survey	4	Networking	1
Topic	10	Logic	2	Patience	1
Understanding	2	Methodology	6	People	1
Variables	7	No Plagiarism	1	Presentation	2
		Originality	1	Problem Statement	2
		Patience	1	Professionalism	1
		Proof Work	1	Proof Work	1

FIRST ELEMENT		SECOND ELEMENT		THIRD ELEMENT	
Keywords	#	Keywords	#	Keywords	#
		Reference	1	Quality	1
		Resources	5	Reference	2
		Results	3	Report Writing	3
		Sampling	3	Resources	4
		Scope	1	Results	8
		Selection	1	Sampling	4
		Set The Scene	1	Searching	1
		Significance Of The Study	2	Selection	1
		Simplicity	1	Significance	4
		Technicality	1	Skills	5
		Technology	1	Surveys	1
		Title	1	Technology	1
		Topic	1	Topic	3
		Understanding	2	Understanding	1
		Variance	1	Variables	1

It can be inferred from Table 1 that students had different perceptions about the key elements of research. The keywords reveal that most students offered a rather vague or general idea of what research meant to them by comparison to an understanding of those who might have been involved in active research for some time. Most student responses indicated that they viewed research from technical perspectives, while for some, the concept of research was considered more from a socio-psychological perspective associated with keywords such as creativity, patience, dedication, etc. The responses revealed that students were limited in their associations of research with research papers. Using the responses, a word map was created to identify the intensity of keywords (see Figure 6).



Figure 6: Word Map for the First Element

As is clear from Figure 6, knowledge of the discipline/subject/topic is understood as an important first element of research. Some students reported keywords that related to the sequence in which they draft a research paper, by including terms such as introduction, aims and objectives, etc. as the first element.

In their second choice elements, many respondents considered dedication as a key feature of research, while results and conclusions also related to the ways that research might be conducted or reported (see Figure 7).



Figure 7: Word Map for the Second Element

Figure 8, showing responses for the third element they identified, indicates that respondents' ideas of research are quite focused on concerns about knowledge, but other associated elements start to emerge as they progress from the first to the third element. Although we can observe the use of the words analysis, resources and methodology, which are concerned with research processes, respondents have also given answers such as knowledge, interest, and dedication, which are concerned more with conceptual or socio-affective features.



Figure 8: Word Map for the Third Element

In the following sub-sections, which report on findings addressing Research Question 3 and subsequent research questions, only respondents who selected *Yes* responses (n=119) to Research Question 1 are included.

Research Question 3: (a) Have students ever been taught research skills? (b) If they were, at what level?

A comparatively high percentage of respondents (63%) reported that they had not been taught research skills, while only 37% had been taught research skills during their studies (see Figure 9).

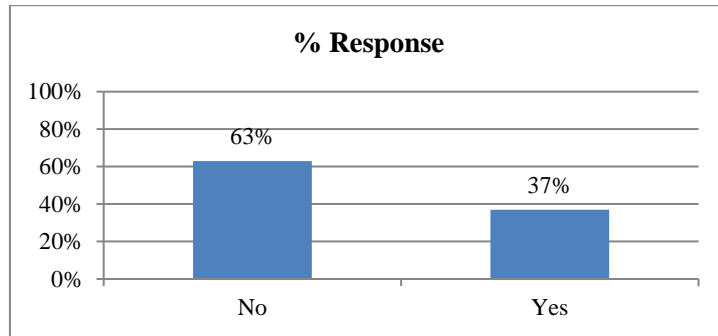


Figure 9: Percentage of Students taught Research Skills (in %)

Of the 44 respondents who reported that they were taught research skills during their studies, most of them (70%) were taught research during their undergraduate degree. From Figure 10, it can be inferred that such skills are generally not included or integrated at school levels.

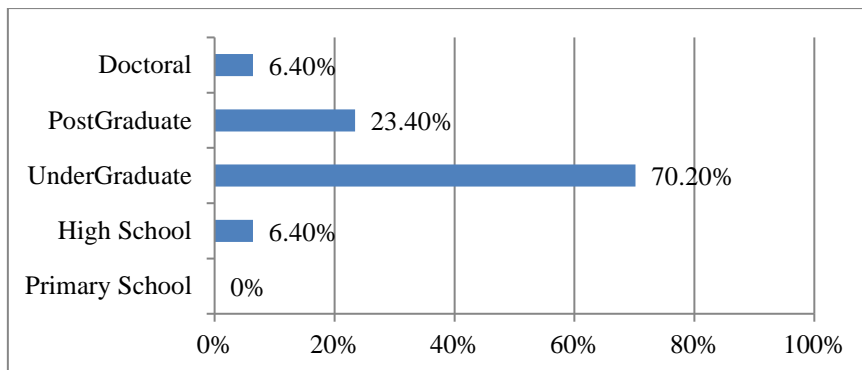


Figure 10: Percentage of Respondents taught Research Skills by Educational Level

Research Question 4: (a) Do students feel that they have research skills? (b) If yes, what kind of research skills do they possess?

Fifty-two percent of the respondents felt that they had research skills, 11% felt they did not have these skills, and 37% were not aware of whether they possessed such skills (see Figure 11). It might be assumed that those who were not aware they possessed research skills might not need to use them during their studies.

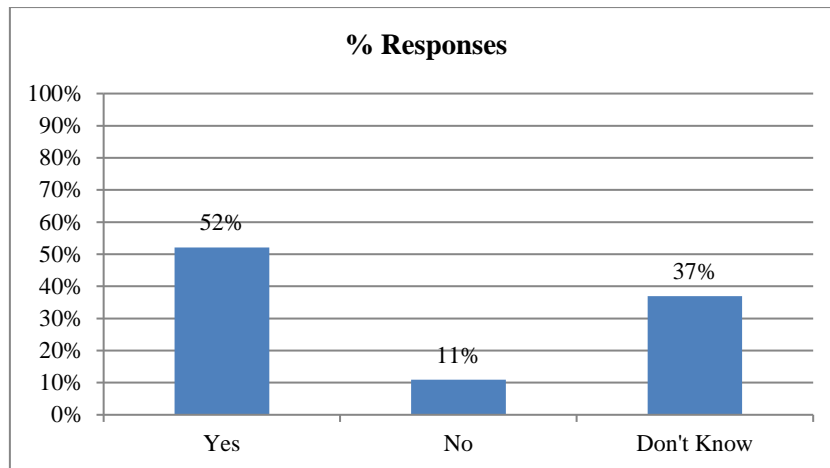


Figure 11: Responses for possessing Research Skills (in %)

For those respondents who felt they had research skills, the kind of research skills the students felt they possessed were reported (see Figure 12).

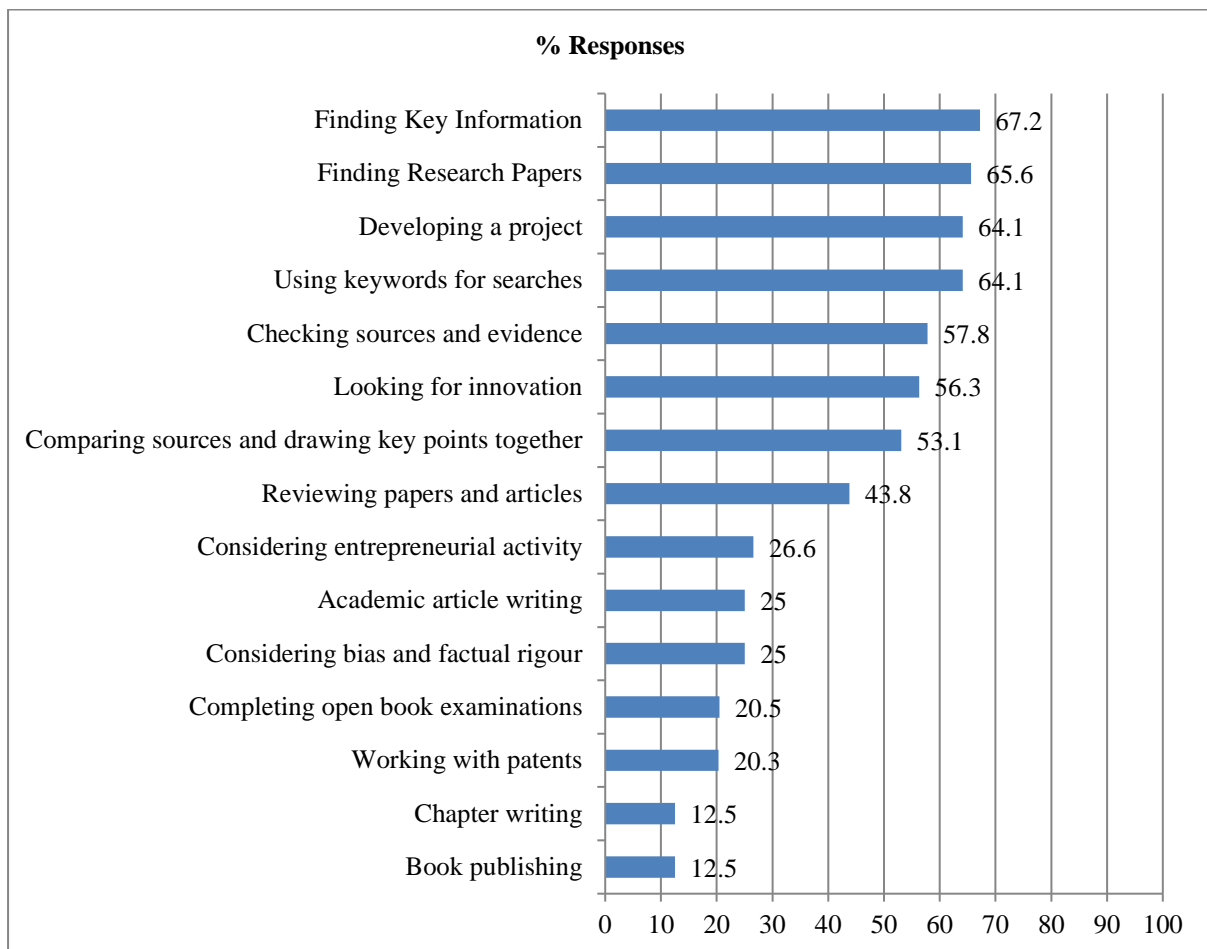


Figure 12: Kind of Research Skills Students reported they possessed (in %)

It can be inferred from Figure 12 that students mostly reported possessing information searching skills. The respondents also reported that they had skills required to develop a

project. It can be argued that as project development is a compulsory part of the undergraduate engineering courses in Indian higher educational institutions, then it is not surprising that a higher number of respondents felt that they had those skills. However, it is possible that project development does not highlight the presence of research skills among and for students.

Research Question 5: Do students feel that research skills are useful?

Out of the total respondents, 95% felt that such skills are useful. Five percent of them were unaware of their benefits, although it is possible that they might not have used such skills (see Figure 13). This response indicates that most students recognise the importance of having such skills.

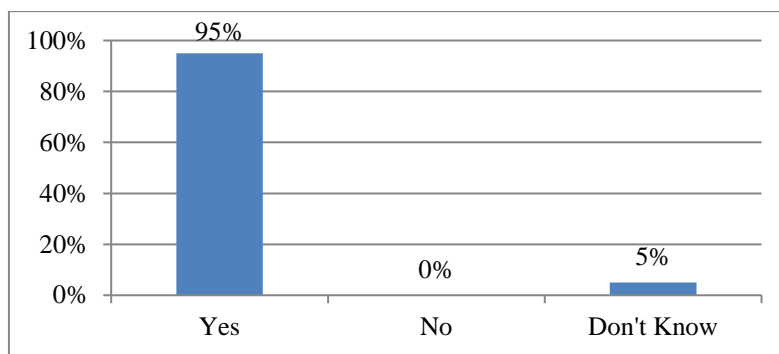


Figure 13: Responses of whether Research Skills are useful (in %)

Research Question 6: (a) Do the students feel that the research skills should be part of the curriculum? (b) If yes, how much (percentage) of the research component should be added to the curriculum?

Eighty-two percent of the respondents felt that research should be part of the curriculum; a very low percentage of the respondents felt that it should not form part and 12% did not offer an opinion (see Figure 14).

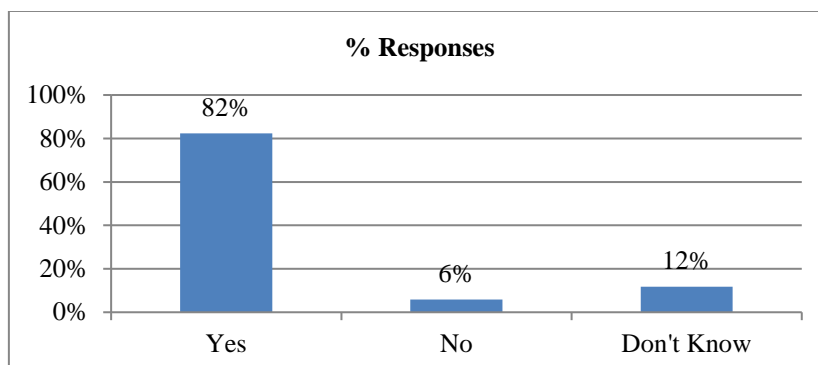


Figure 14: Responses for adding a Research Component to the Curriculum (in %)

Thus, overall, the students felt that including a research component in the curriculum would be beneficial.

(b) If yes, how much (percentage) of a research component should be added to the curriculum?

Different answers were received to this question. Eighteen percent of the students, which is the highest ratio, felt that the research component should be added to the curriculum completely. Over 50% felt that at least 70% of the curriculum should involve research skills (see Figure 15).

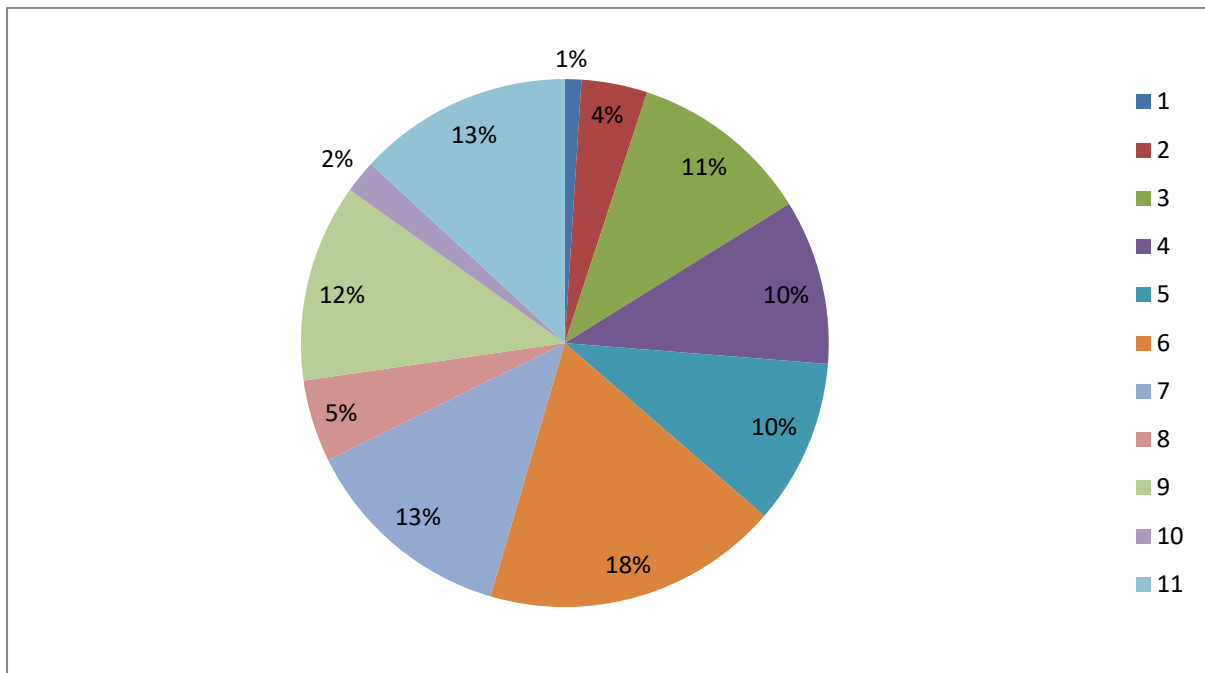


Figure 15: Percentage of Research Component suggested in the Curriculum

[The size of the pie indicates the percentage suggested in the curriculum, while the colours show suggested contribution, 1=0%, 2=10%, etc., up to 11=100%]

Research Question 7: Do the students feel that if the research is added to the credit system, it would improve the learning outcome?

Eighty percent of students felt that including research in the credit system would improve the learning outcome. Nine percent felt that it would not have any effect while 11% were not able to give any opinion (see Figure 16).

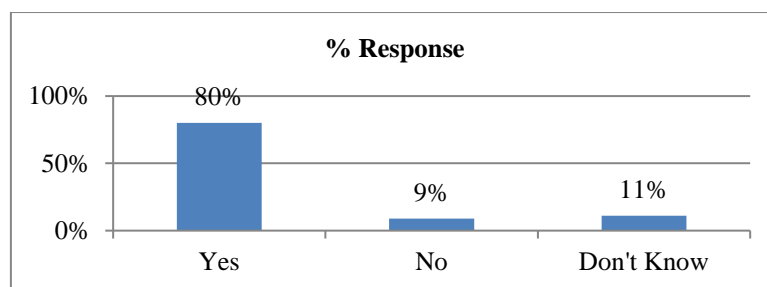


Figure 16: Responses to whether Research added to the Credit System would improve Learning Outcomes (in %)

Research Question 8: Do the students feel that the research skills can be integrated through teaching?

Fifty-eight percent of respondents strongly felt that research could be integrated through teaching, 40% partially felt so and 2% felt that these could not be taught (see Figure 17).

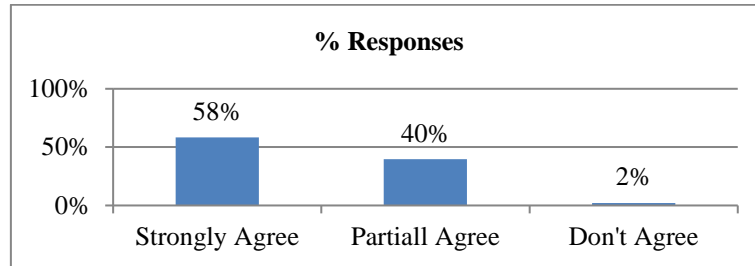


Figure 17: Responses to whether Research can be Integrated through Teaching (in %)

Research Question 9: Do the students feel that the research skills will enable them to conduct scientific research?

Seventy-three percent said that if the research skills were taught, it would improve their research skills and would help them to conduct scientific research (see Figure 18).

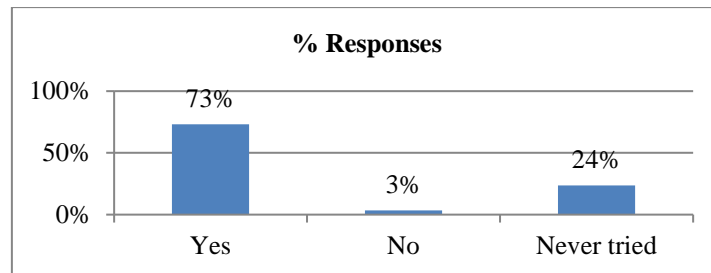


Figure 18: Responses to whether Research Skills will enable Scientific Research (in %)

If not, reasons given are shown in Figure 19.

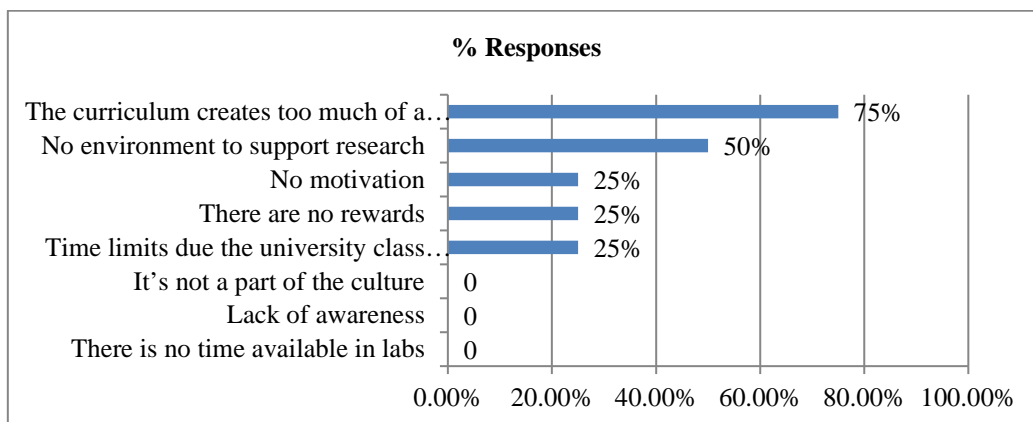


Figure 19: Reasons for Research not enabling Scientific Rigour (in %)

Figure 19 shows that around 75% of the respondents felt that the curriculum creates too much burden and it would be difficult to conduct research even if the research skills were taught to them. Around 50% say that there is no environment to support research and imparting such skills would make no difference.

Research Question 10: Do the students feel that the faculty need training for teaching research skills?

The majority of the respondents (87%) felt that faculty do require training for teaching research skills, while only 13% felt that no faculty training was required (see Figure 20).

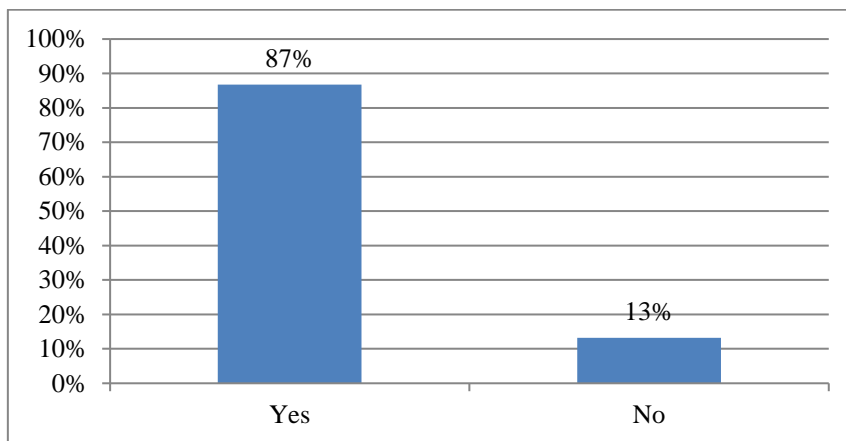


Figure 20: Responses to whether Faculty require Training (in %)

Research Question 11: How the students rate themselves on different research skills on a scale of 1-5?

It can be inferred from Figure 21 that only about 30% of students had the core research competencies such as knowledge of research methods, documentation and reporting as well as an understanding of ethical, health and environmental considerations. The results also indicate that more than half of students have the desire to learn and possess the abilities required to conduct research investigations.

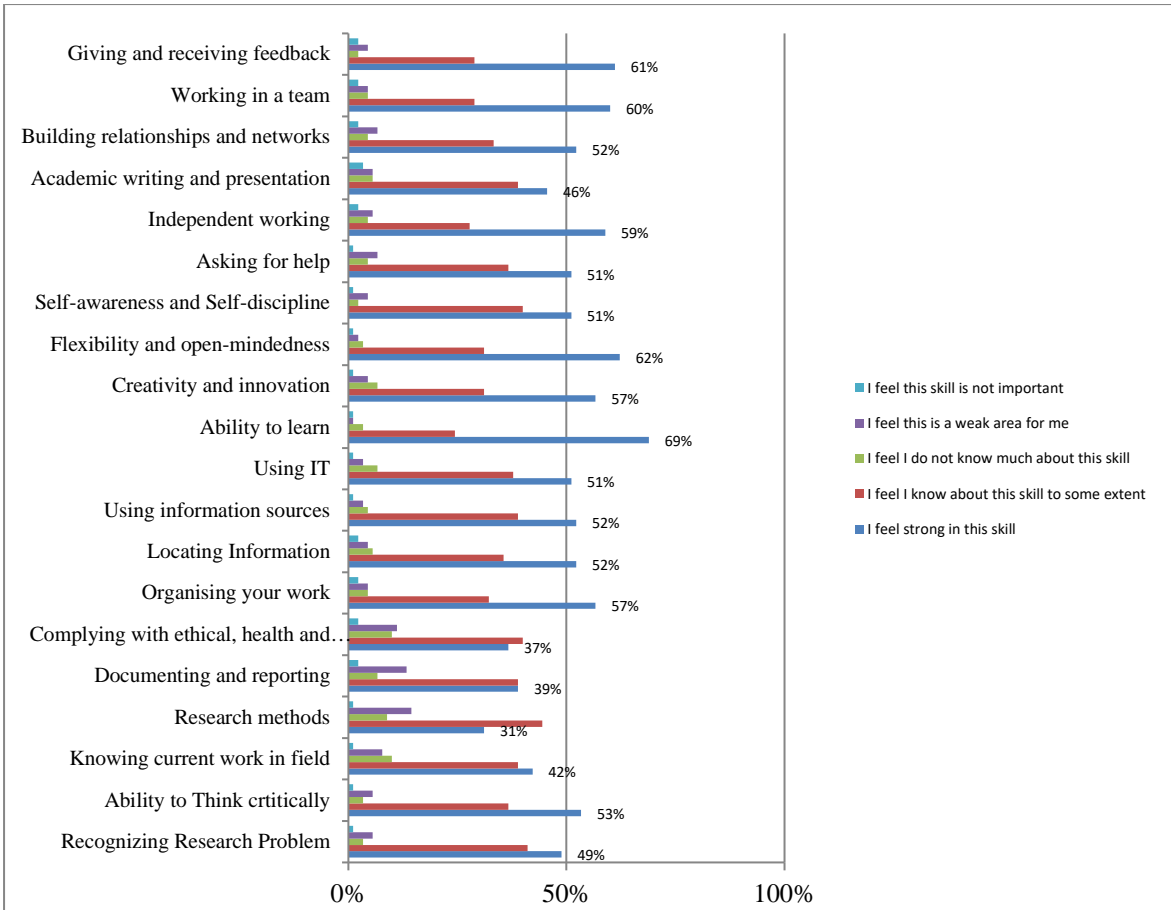


Figure 21: Self Assessment by Students on various Research Skills (in %)

Figure 21 shows that respondents do not rate themselves very highly in many of the skills. Around 60-69% of the respondents felt that they possess a strong ability to learn, have flexibility and open-mindedness, ability to work in teams and capability to receive and provide feedback. However, it can be inferred that many students are not very positive about the core research skills.

Data Analysis considering Undergraduate and Postgraduate Students separately

Distribution of undergraduate and postgraduate students by year of study

Figure 22 gives the distribution of undergraduate (UG) and postgraduate (PG) students by year of study.

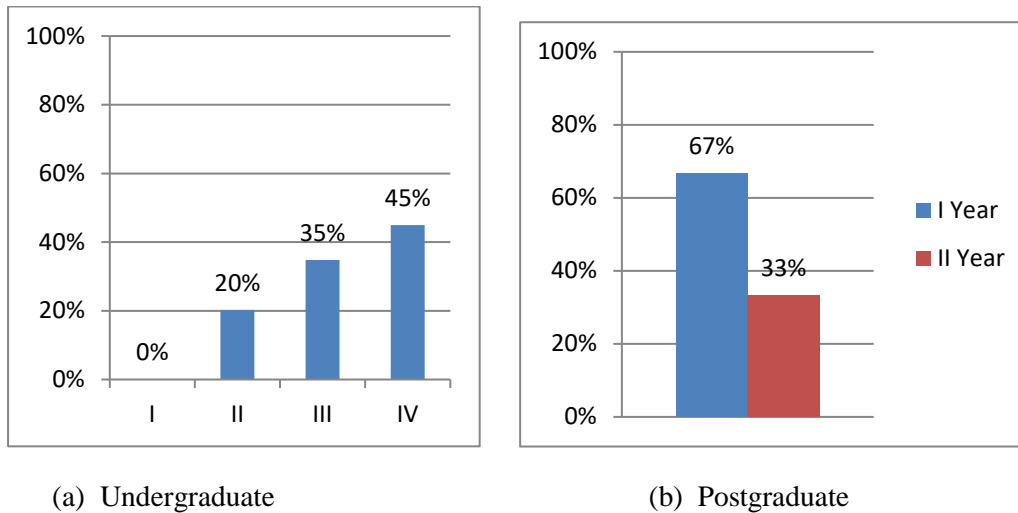


Figure 22: Year-Wise Distribution (in %)

Research Question 1: Were you taught research skills?

Figure 23 shows that almost all the postgraduate students were taught research skills, while only 33% of the undergraduates have been taught research skills. This suggests that there is very weak integration of research at undergraduate level.

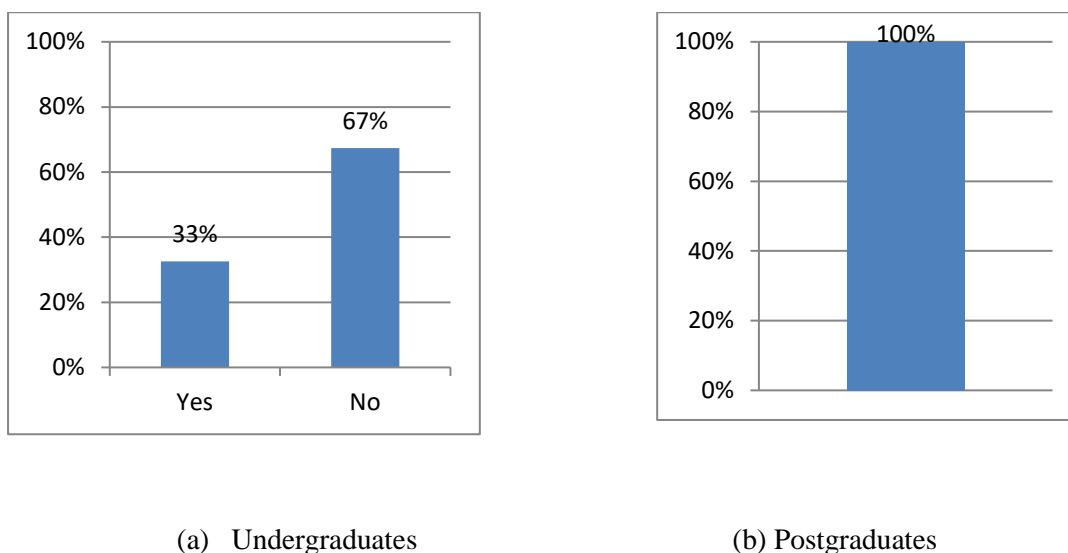


Figure 23: Responses for whether Research Skills were taught (in %)

Research Question 1: a) If taught, at what level?

Figure 24 clearly indicates that research skills are not taught at the school level. The research starts becoming important at the undergraduate level and becomes strong at the postgraduate level. Thus, the importance of inculcating research skills is understood very late in a students' career.

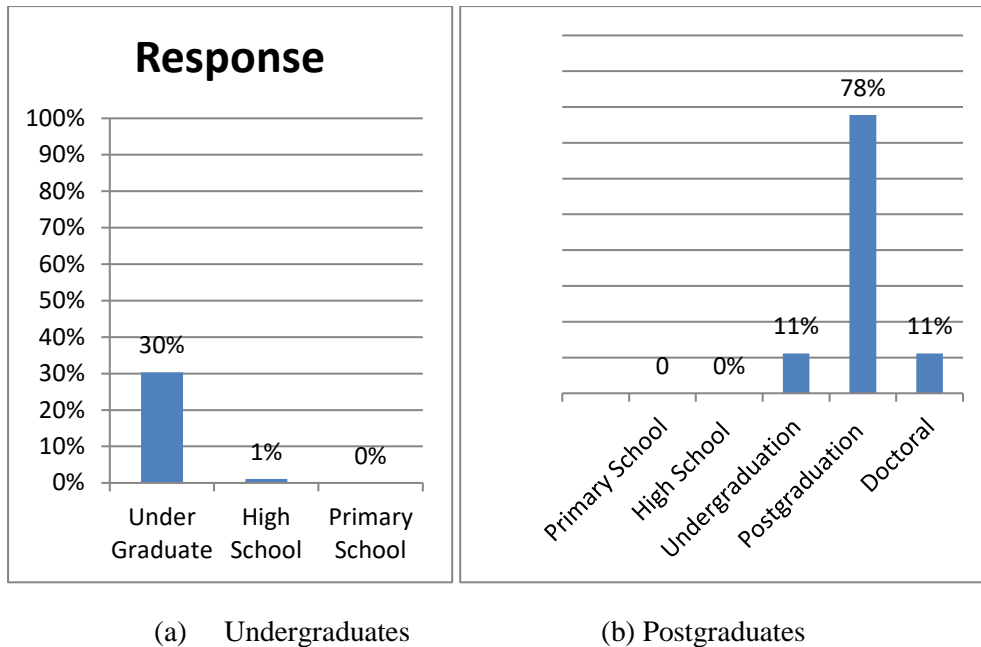


Figure 24: Level at which the Students were taught Research Skills (in %)

Research Question 2: Would you say you have research skills?

We can see clear differences between undergraduate and postgraduate students (see Figure 25). Postgraduates feel that they possess research skills. However, only 48% of the undergraduates feel that they have such skills.

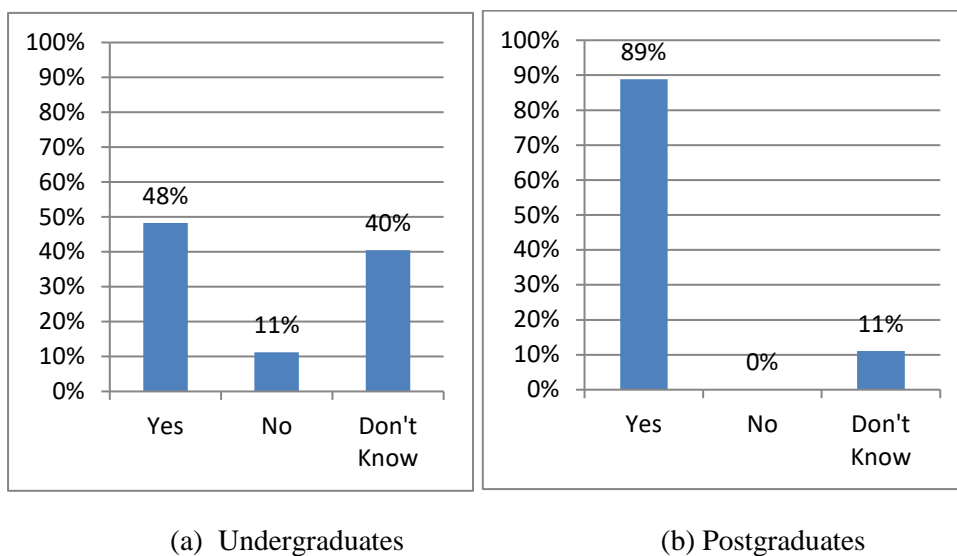


Figure 25: Responses for whether Students possess Research Skills (in %)

Research Question 3: Do you think research skills are useful?

Research skills are considered to be important at both undergraduate and postgraduate levels as can be seen in Figure 26. But it is surprising to find that the proportion of students who feel the value of such skills is higher at the undergraduate level. Moreover, there are students at the postgraduate level who can perceive its importance.

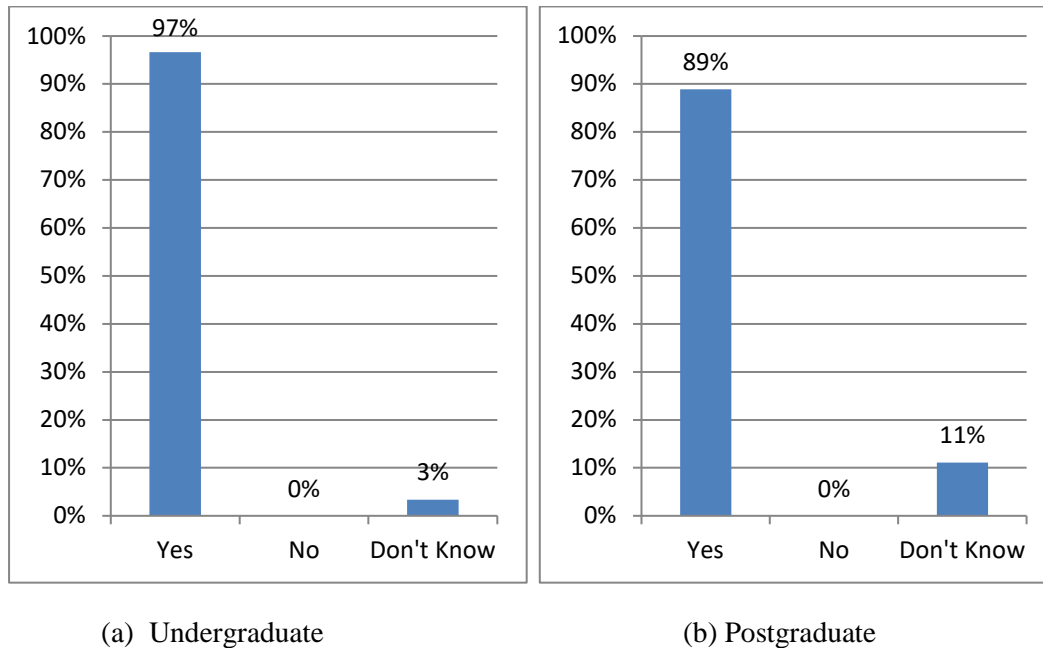
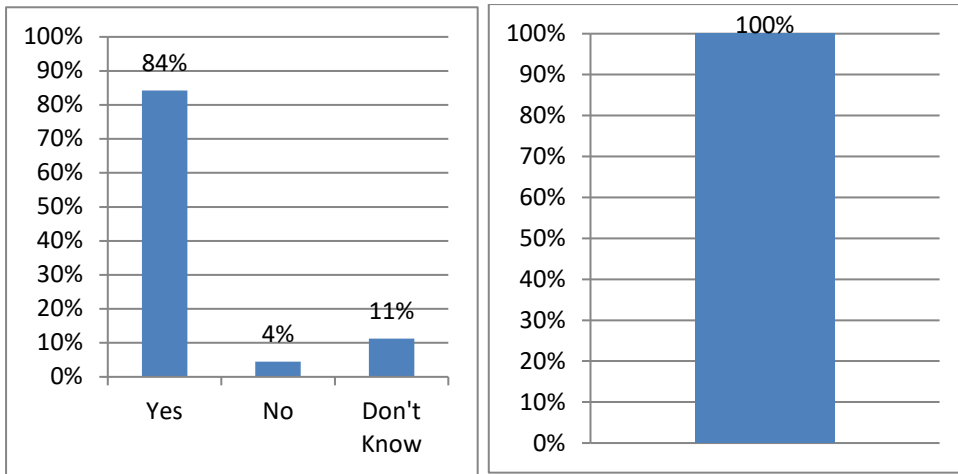


Figure 26: Response to whether Research Skills are important (in %)

Research Question 4: Do you think research should be included as part of the curriculum of your courses?

Both undergraduates and postgraduates strongly feel that research should be part of the course curriculum. One hundred per cent response rate at the postgraduate level indicates that the students feel that it should be part of the curriculum, although a small number of undergraduates fail to understand its importance as indicated by Figure 27.



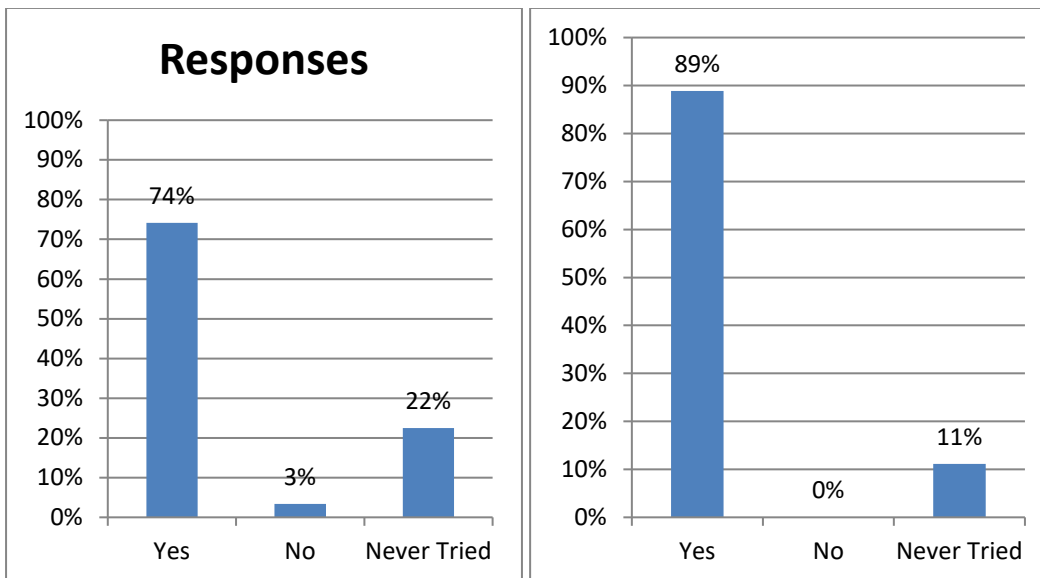
(a) Undergraduate

(b) Postgraduate

Figure 27: Response to whether Research should be Part of the Curriculum (in %)

Research Question 5: If research skills are taught to you as a student, do you think you will be able to do scientific research?

Figure 28 clearly indicates that the importance of research skills in pursuing scientific research is perceived by both undergraduate and postgraduate students. It can also be seen that there are postgraduate students who hold no viewpoint.



(a) Undergraduate

(b) Postgraduate

Figure 28: Response to whether Research Skills will improve Scientific Research (in %)

Research Question 6: If research is added to the credit system, do you think it will improve your learning outcome?

Higher proportions of both undergraduate and postgraduate students feel that research integrated into the credit system will improve their learning outcomes (Figure 29).

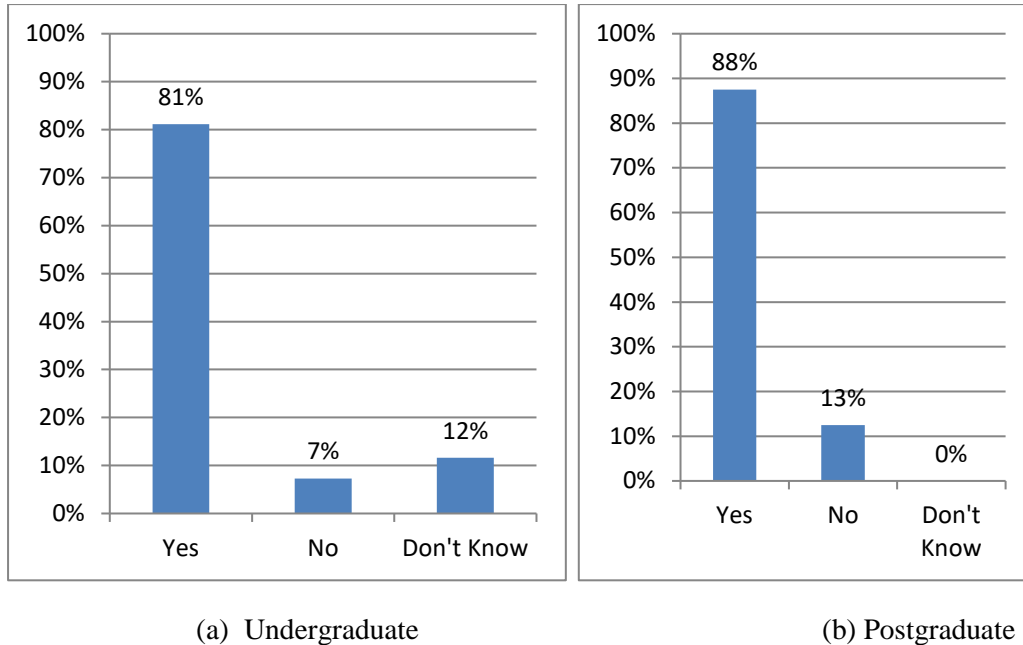
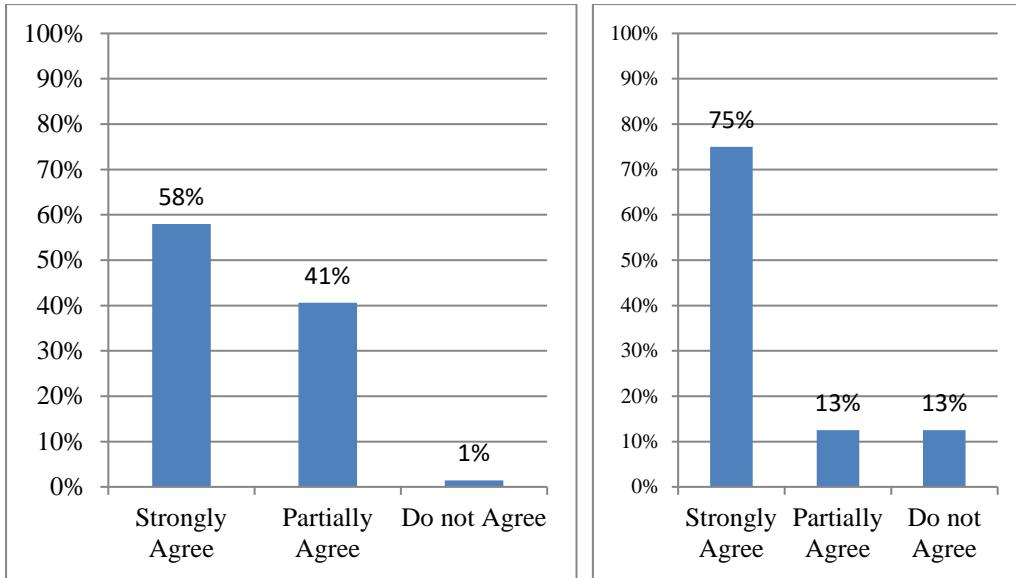


Figure 29: Response to whether Research will improve Learning Outcome (in %)

Research Question 7: How much do you agree that research skills can be integrated through teaching?

The results in Figure 30 indicate that students at both levels feel that research skills could be integrated through teaching. Although there is a higher proportion of students at the postgraduate level who do not agree that research could be taught. We could thus presume that although research is part of the postgraduate curriculum, the students are not satisfied with the way it is taught.



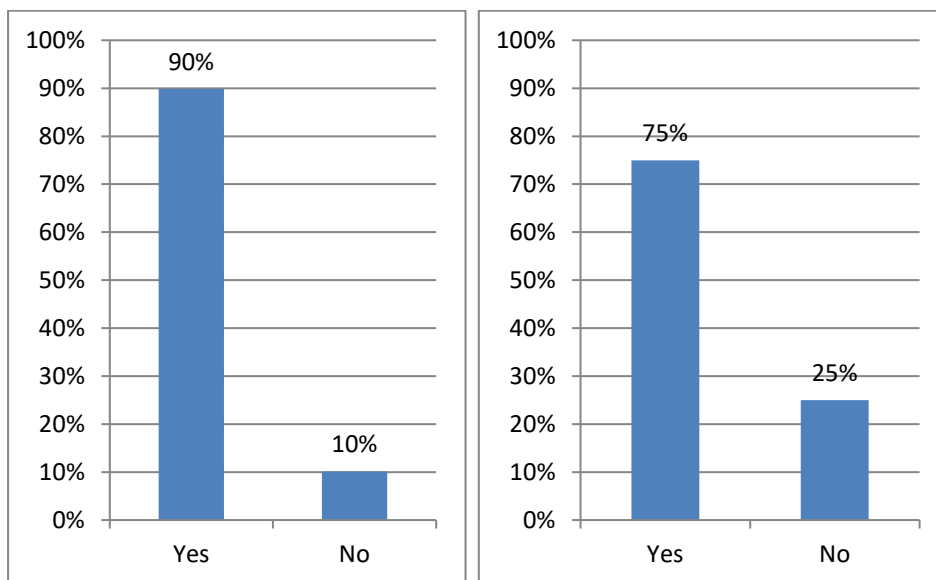
(a) Undergraduate

(b) Postgraduate

Figure 30: Response to whether Research Skills can be integrated through Teaching (in %)

Research Question 8: Do you feel faculty need training for teaching research skills?

The results in Figure 31 indicate that 90% of students feel that teachers at UG level require training for imparting research skills. Furthermore, although the postgraduate students are provided with research knowledge by their teachers, they still feel that their instructors need adequate training.



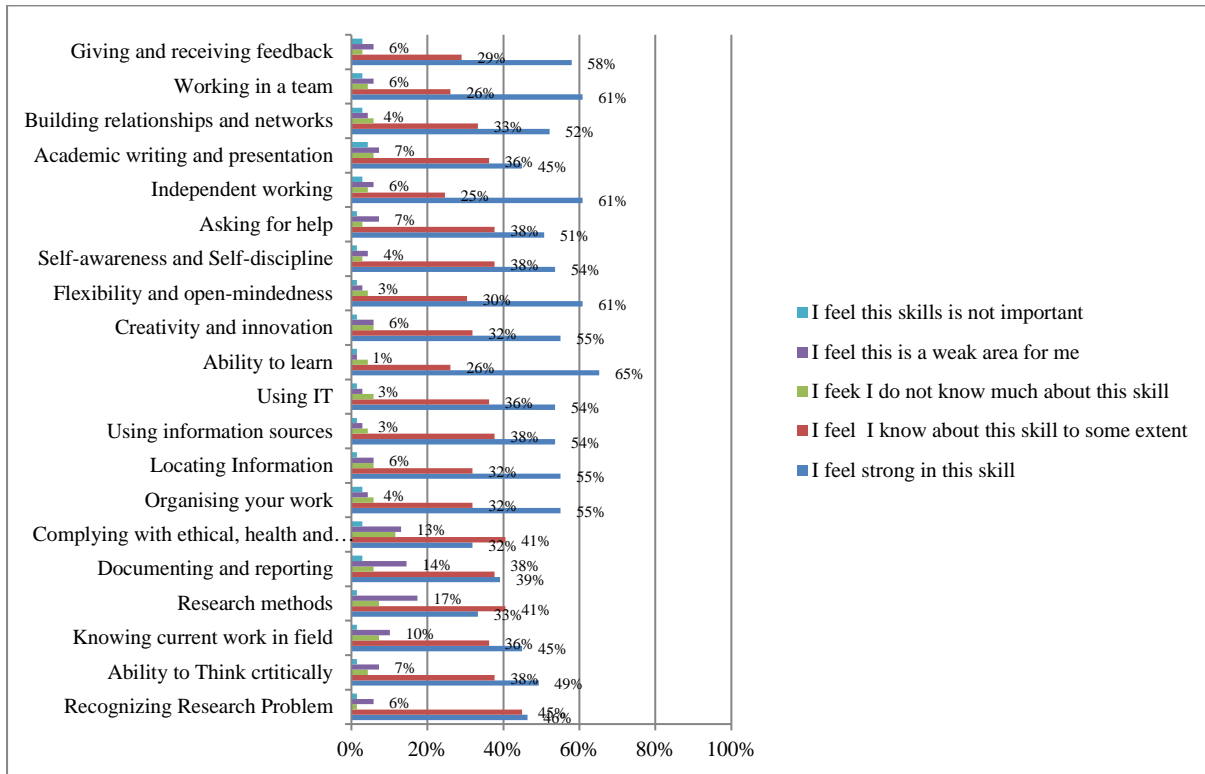
(a) Undergraduate

(b) Postgraduate

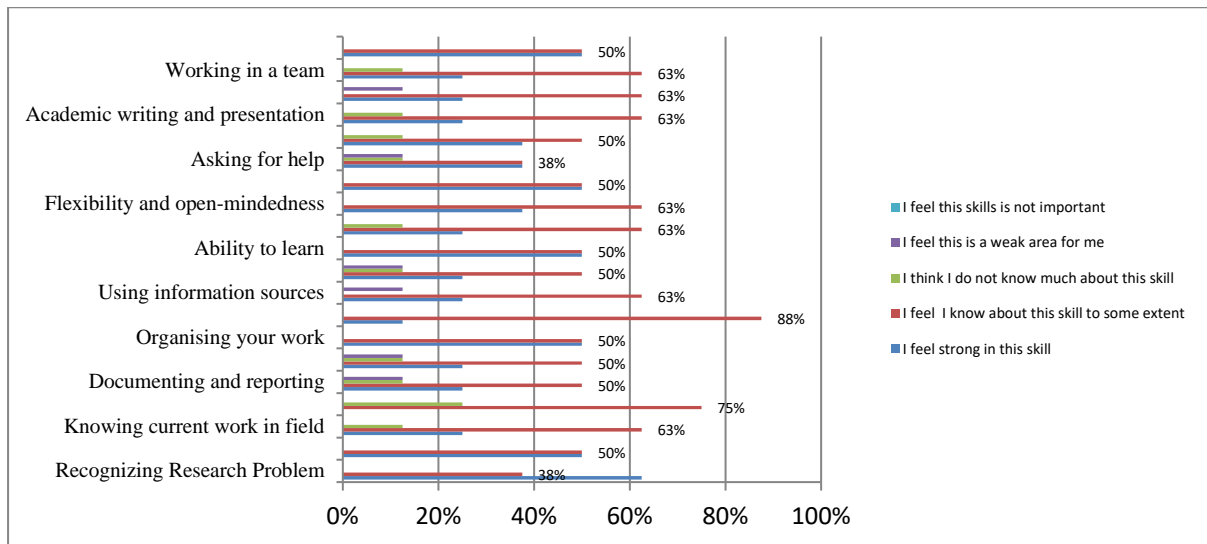
Figure 31: Faculty need Training (in %)

Research Question 9: Assess your research skills on a scale of 1 to 5.

Figure 32 indicates that postgraduate students have comparatively more research skills than undergraduate students.



(a) Undergraduate



(a) Postgraduate

Figure 32: Self-assessment by Students of Research Skills (in %)

6. Discussion

For this study, 4th year, 3rd year and 2nd year undergraduate engineering students were the main respondents (35%, 28% and 33% of the total number respectively). At the time they completed the survey, fourth year students would have already completed term papers, industrial training, minor projects and have undertaken a major project which was near completion. Third year students would soon start with minor projects. Term papers, minor and major projects would all have included a research component. Master of Technology (M.Tech) courses they follow are completely research-based, where the focus is on research from the very first day. First year M.Tech students might have published research papers, while second year students would be doing their dissertation and might have completed their research work.

Despite introducing research-based courses into the engineering curriculum, there are significant numbers of students who are unaware of the term “research” from their courses (24%) and many strongly felt that they lacked research skills (11% felt they did not and 37% were unaware of whether they possessed them or not). This indicates that some courses are ineffective in imbuing the requisite research skills among their students. It might be assumed that the whole purpose of introducing such courses is not clear to curriculum designers, faculty and the students. Furthermore, many students were not able to give a clear response when prompted about their ideas of the three main words or phrases that they would use to describe research. The responses tended to be rather vague across all years for undergraduate students and it might be inferred that many research-based projects were not adding value to their skill set. Our starting assumption has been supported by the fact that most of the students (63%) said that they were not taught research skills. Though the focus of any nation is on increasing research and innovation, no research skills are being inculcated, according to these results, in a specific region in India until the student passes beyond high school and pursues an undergraduate degree. However, a considerable number of students at the undergraduate level did not report possessing research skills. Of all the requisite research skills, students mostly possessed information searching skills (finding key information, finding research papers, using keywords for searches, and checking sources and evidence). The respondents did report that they had skills required to develop a project, but it can be argued that as project development is a compulsory part of the undergraduate engineering courses in Indian higher educational institutions, then a higher number of respondents would be found who would report that they felt that they had those skills. It is possible, nevertheless, that project development does not highlight the presence of research skills among and for students. Engineering students (95%) certainly understood that research skills were useful. This response level is in line with the investigations conducted among medical and management students. Students strongly felt (82%) that research should be part of the curriculum and adding it to the credit system would improve both scientific rigour and overall programme learning outcomes (stated by 80%). Over half of the students felt that research should be a major part of the curriculum.

While many students (up to 69%) felt that they had abilities to learn, a far lower number (only some 30%) felt they possessed core research skills. Introducing research skills into the

curriculum was felt by students to itself be potentially challenging. Many students (87%) felt that faculty would need training in order to do this.

Although our data provided only a small number of responses from postgraduate students (8 in total), the differences between responses from undergraduate (UG) and postgraduate (PG) students are nevertheless of interest as they show possible interesting trends. For example, all postgraduate students were taught research skills, compared to only 33% of undergraduate students. Similarly, 89% of PG students felt they had research skills, compared to 48% of UG students. A higher proportion of PG students felt that research skills could be integrated into the curriculum, while a higher proportion of UG students felt that faculty would need to be trained to do this. Our respondents at both undergraduate and postgraduate levels could perceive the importance of research skills in pursuing scientific research as well as improving their learning outcomes if added to the credit system. Furthermore, students at both levels felt that research skills could be integrated through teaching, although there was a higher proportion of students at the postgraduate level who did not agree that research could be taught. We could thus presume that although research is part of the postgraduate curriculum, the students are not always satisfied with the way it is taught. Our assumption is supported by some responses indicating that their instructors need adequate training. The case is the same at the UG level, where 90% of students felt that teachers required training for imparting research skills. Self-assessment of research skills indicates that postgraduate students have comparatively more research skills than undergraduate students do. Thus, it could be inferred from the study that mere inclusion of research-based courses into the curriculum does not guarantee the inculcation of such skills among the students. Thus, there is a strong need for imbibing such skills among the students through adequate instructional pedagogies and an appropriate curriculum.

7. Conclusions

We now return to our starting question - Do we cultivate research skills? To what extent can this be said to be a concern with veracity versus falsity?

Research skills are important graduate attributes, and it is assumed that these are inculcated through research-based courses such as term papers, projects, independent research study, etc. To date, we have just presumed that we have imbibed such important skills among the students through these courses, but we have never actually revisited and cross-verified whether such courses are actually serving their purpose. Our study clearly shows a considerable number of engineering students are unaware of the research term from their courses, and subsequently, a fraction who are not sure whether they possess such skills. Furthermore, most of the students in our survey did not give key words or phrases in their answers regarding what are regarded as key elements of research related to innovation, analysis and creativity. Our assumption that research skills were not being adequately developed was further confirmed when the students said that they learnt such skills to some extent only at the undergraduate level, and then more so at the postgraduate level. Students certainly appear to miss out on the earlier development of these skills at the primary learning stages in primary and high schools. Without arguing about the level at which such skills should be inculcated, it is surprising to see that graduates are very weak in their self-reported abilities with research skills. The acquisition of research skills is a 'must' for students (and engineering students in this case) as it opens new doors to enormous opportunities.

Engineering students need to be imbibed with research skills as important attributes. However, to do this, the imparting of research skills needs to be appropriately considered as an important aspect of undergraduate programmes. In exploring this requirement, we began by considering higher education institutions in India as our opening point. Our study started by finding out the dimensions of research skills where students report understanding, from a population in India covering the Delhi National Capital Region of India region. The students involved stated their perspectives about the value they ascribe to research skills in their curriculum. From their evidence, we arrive at the judgement that students feel that research skills could be integrated more fully into the curriculum and that faculty will need to be trained to do this.

So far, our findings support the view expressed in our problem statement. We argue that there is an urgent need to reconsider the position of research skills in the curriculum.

We recommend:

1. A change in pedagogy, to inculcate research skills among students.
2. Revisiting the assessment criteria for evaluating research components.
3. A course on research methods, introduced at the undergraduate level.

4. Accreditation bodies to not just focus on the number of research articles published by students as a measure of research attribute, but also the methods used to inculcate such skills among the students.

5. The importance of research needs to be recognised at the very late education stage – undergraduate or postgraduate levels. But we argue that if such skills are imparted at earlier stages of education, then it can bring in more interdisciplinary and multidisciplinary research.

Our study is still in-progress. We intend to gain evidence from more PG students in the study, to gain more detailed results about the maturing of skills of research across students at both UG and PG levels. We aim to involve other regions of the country and we will conduct the survey at a wider international level. This latter international survey will allow us to see whether countries like the USA and the UK focus more on research at different levels of education. We will be able to follow up on gaps from those surveys, to help us explore how to improve the quality of undergraduate education in India.

Our subsequent research will seek to address the limitations we recognise in our work at this early stage:

- We have a limited sample population and population size. To address this, we will conduct our survey at a wider national level and international level to explore more exactly the gaps in the higher education system in India.
- We have limited our questions in the survey. Undergraduates are lacking in research skills because of their perceived gaps in the education system in India. These gaps will be identified more exactly by taking this research to an international level. Additional survey questions will help in detailing the gaps more precisely also. For example, we will ask students to identify which course(s) they can choose which actually impart research skills to them.

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